SUPPLEMENT TO "THE ELECTRICAL ENGINEER," DEC. 30, 1892.

THE

ELECTRICAL ENGINEER.

A WEEKLY JOURNAL OF ELECTRICAL ENGINEERING,

WITH WHICH IS INCORPORATED

"ELECTRIC LIGHT."

VOLUME X. (NEW SERIES.)

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1892

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NOTE.—General Articles, Correspondence, and Companies' Meetings are indicated by heavier type (thus, 290) than the Notes and Business Notes, references to which are shown by light type (thus, 290).

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THE

ELECTRICAL ENGINEER.

No. 1, Vol. X. LONDON, JULY 1, 1892. PRICE 3D.

NOTES.

Manchester Town Hall.—Tenders for wiring this building must be sent in by July 5th to the Gas Committee, Manchester.

Antwerp.—An electric railway between Antwerp and Brussels, to do the journey in 25 minutes each way, is proposed to be carried out shortly.

Titles.—A good title for a play depending upon a message by telephone would be "Are you there?" It would be equally good as a general motto for the "National," especially the "query."

Carshalton.—Tenders are asked for the lighting of Carshalton with gas, oil, or other illuminant, at per lamp, exclusive of the cost of columns and lanterns, for 12 months from end of July. Tenders to Mr. J. W. Manley, clerk, by July 6.

Electric Traction in Belgium.—An electric overhead conductor railway is thought of from Place Rouppe to La Petite Espinette. The Thomson-Houston system have the matter in hand. The present traction is by steam engines.

Varley Testimonial.—The meeting called for to-day (Friday), at 4 p.m., with reference to the proposed Varley testimonial, will be held in No. 4 room, Westminster Palace Hotel, instead of at the offices of the Institution of Electrical Engineers.

Electric Cranes.—Besides the contract for two electrical cranes for the Southampton Harbour Board, Messrs. J. G. Statter and Co. have recently secured the order for three 23-unit dynamos at Lord Rothschild's installation at Tring Park.

Alternate-Current Dynamos.—Messrs. Mather and Platt have sent us their catalogue of alternate-current dynamos, showing machines both with direct-driven exciter and separately excited. They are for 1,000 to 2,000 volts, and from 16 up to 200 amperes.

Guildhall.—At the meeting of the Commissioners of Sewers on Tuesday, on the motion of Mr. Graham King, seconded by Mr. Williamson, it was referred to the engineer to submit to the Court the cost of lighting the Court-room and offices by means of electricity.

Spanish Telegraphs.—The Direct Spanish Telegraph Company, Limited, state that the Spanish inland telegraphic system, which has been stopped since the 20th ult., is now working, and they have direct communication with Madrid and all parts of Spain by their Bilbao cable.

Hove.—Referring to the inactivity of the special committee appointed to consider the subject of electric lighting at Hove, a member of the Council (Mr. Usher Robins) suggested at a meeting last week that the committee shall be renamed the "Electric Darkness Committee."

Lithanode Cells.—A considerable number of road-cars have now been fitted with lithanode battery lamps. A type of solid accumulator which we described some months ago is being developed, and is likely, we think, to render considerable service in accumulator traction.

Southampton.—A letter was read at the Southampton Town Council meeting last week from Mr. J. T. Hamilton, secretary of the Southampton Electric Light and Power Company, offering to supply electric power for lighting the municipal offices and other public buildings. This was referred to the Estates Committee.

Central Electric Railway.—Lord Morley's Committee of the House of Lords last Friday passed the Bill promoted by the Central London Railway Company empowering them to extend their authorised system from the Mansion House to Liverpool-street Station. This Bill has now been sanctioned by both Houses.

Conversazione.—The *conversazione* of the Institution, it will be remembered, takes place to-night (Friday), and a large meeting may be expected. In view of the limited amount of cloak-room at the Royal Institute of Painters in Water Colours, it would be desirable if visitors were to use soft hats or opera hats on the occasion.

Huddersfield.—The Local Government Board have sanctioned the borrowing of £12,000 for buildings in connection with electric lighting, and £38,000 for general purposes in connection with electric lighting, the former to be repaid in 30 years, the latter in 15 years. It has been decided to insure the tramway boilers.

Guildford.—At last meeting of the Guildford Town Council, the town clerk stated that he had received a letter from Mr. J. N. Shoolbred, enclosing his report on the electric lighting of the town. It was agreed to read the report in committee at the conclusion of the general business, and then to refer it to the Electric Light Committee.

The Election.—The Postmaster-General has issued notices warning telegraph operators not to approach candidates with references to their grievances, and forbidding meetings held without notice to the department, or without official reporter. The telegraphists greatly object to this action as curtailing their privileges as holders of the franchise.

Paignton.—Two tenders were received at the last meeting of the Paignton Local Board for keeping the electric bells connecting the police station with the fire stations in order for 12 months. Mr. John Toby tendered for £12. 12s., with certain prices for new materials; Messrs. McCormack tendered for £14. The matter was referred to the same committee as dealt with the fire brigade question, being found somewhat complicated.

Electioneering Lamps.—Colonel Wyndham Murray has been furnished with a portable electric handlamp for carriage use or for lecture purposes, made by the Lithanode Company. The lamp, which is handsomely mounted, is provided with two socket contacts, so that the light is given either generally or cast downwards with the glare guarded

from the speaker's eyes. It is very useful form of electric handlamp.

Midget Arc Lamps.—We have recently carried out some tests with the well-named "Midget" arc lamp. It takes five to six amperes at 40 to 45 volts, giving about 200 c.p., and for interior work is an admirable arc lamp. It burns noiselessly and steadily, and the small opal globe with which it is provided allows it to give a very soft and pleasant, though brilliant, light.

Electric Pumping Plant. — Messrs. Ernest Scott and Mountain have just completed a large electric pumping plant to the order of Messrs. G. B. and T. E. Forster for North Seaton Colliery. These pumps are claimed to be the largest electric pumps that have up to the present been made. We hope to be able to give full details when the installation is at work at the colliery.

Bournemouth.—Notice was received by the Bournemouth Town Council at their last meeting from the Bournemouth and District Electric Supply Company of their intention to lay underground mains along several principal roads, and it was resolved that consent be given subject to the company depositing plans drawn to a proper scale, and subject to the approval of the surveyor.

Electric Sailing Gig.—H. Smith, Esq., of Stile Hall, Chiswick, has had an electric sailing gig constructed for use on the Norfolk Broads. The boat is built of teak, and runs at 6½ miles an hour, being fitted with electric motor driven by E.P.S. cells placed below the water-line. The boat can be rowed, sailed, or electrically propelled at pleasure, accommodating six persons comfortably.

Alternators in Parallel.—With reference to our note on parallel running of alternators, we are informed that at the Bournemouth central station the Mordey alternators have been run in parallel as required for nearly three years—it is, indeed, the only possible way for them to run, as there is only one main into the town. The machines are two of 37 units and three of 75 units, driven by Brush engines.

Fuse Wires.—Mr. Chas. Wirt, who has devised some good forms of fuses, says the two following rules, the result of much practical experience, if adopted, would save much hesitation and confusion: (1) The length of any fuse should be not less than 20 times its diameter; (2) the length of any fuse should be not less than 1in. for every 100 volts on the circuit in which it is used. The lengths apply to the fuse wire proper, exclusive of terminals.

Personal.—Prof. Francis B. Crocker, president of the New York Electrical Society, is now on a visit to England. Prof. Crocker holds the chair of electrical engineering at Columbia College. He is one of the joint inventors of the Crocker-Wheeler motor, which has met with the greatest success of any small motor, over 100,000 having been put in use in America. Prof. Crocker is a young man, and a prominent official in many electrical organisations in the States.

Electric Cart.—The Ward Electrical Car Company have a brand-new electric cart constructed which will be sent out for use on the streets shortly. The cart, being electric and very much of a novelty, will be used for advertising purposes—and, if we are not misinformed, by a certain establishment whose electricity is mostly flannel. Such are the virtues of anything electric. The Ward Company, by the way, have just taken new premises at 75, Victoria-street, and the electric omnibuses are promised as still coming shortly.

Ferranti Meters.—The demand for small electric meters is now rapidly increasing, and orders received for r meters show a considerable proportion of five-ampere instruments, a size Messrs. Ferranti have recently commenced to make. This demand for small sizes seems to indicate that the number of small consumers is on the increase—a gratifying sign which supply companies will be glad enough to note, and will soon feel in their load diagrams. In this kind of business as well as with the baker, "It's the penny loaf that pays."

Manchester Art Gallery. — The Manchester Art Gallery Committee invite suggestions and tenders from electrical engineers as to the best method of illuminating the entrance hall at the Art Gallery, Moseley-street; also for the lighting of the two new galleries with incandescent lamps similar to the system now in use at the present galleries. The various lights in entrance hall and two new galleries to be supplied from the present dynamos. Further particulars will be supplied by the city surveyor, Town Hall, Manchester. Tenders to be delivered at above office by July 7.

Board of Trade Unit.—The statement having been copied all over the world that the British Board of Trade had determined to call their unit of electrical power *(1,000* watts for one hour) the "kelvin," it is evidently necessary again to call attention to the fact that this proposed name has been abandoned by personal request of Lord Kelvin. The choice still seems to lie between the words "Board of Trade unit," the simple "supply unit"—suggested by Lord Kelvin as an alternative—and the more scientific "kilowatt-hour." The latter is certainly to be preferred for technical use.

Struck by Lightning.—M. Boens gives an account in the Belgian medical *Bulletin* of two young women who were struck by lightning on July 27, 1891, at Nalinnes, Namur, during a violent storm. They were taken to the village doctor, who treated them continuously for two hours, when signs of returning life were seen, and at three o'clock next morning consciousness of both returned, one being soon well, but the other being left with a profound sciatica. Her tongue was also paralysed for two months, but both eventually recovered. The moral which M. Boens justly emphasises is that efforts to revive those struck by lightning should not too soon be given up, as continuous attempts to restore respiration during several hours may result in restitution of life.

Telephone v. Telegraph.—No wonder the Government Post Office is getting fearful that the spread of telephony may interfere with its telegraph business. No wonder they have decided to take the matter into their hands—the question was certainly getting serious. Major Flood Page, at the deputation to the Board of Trade, said that the telephone companies in Great Britain had distributed last year 160 million messages, against a total of 66 millions by the Post Office. We see that a journalist, M. Jean Martin, of the College of Preceptors, advertises he will telephone in French a message of about 400 words for a guinea, the charge for which under old conditions by telegraph would have been 66s., and he evidently makes a good profit for the French and shorthand part of it. The "telepham" will cut out the "telegram."

Wales.—An installation of electric light has been introduced at The Quinta, a well-known establishment at Weston Rhyn, North Wales. The engine and dynamo are laid in the engine-shed near the offices, the building having been rearranged for the purpose. The installation has been carried out by Messrs. B. Verity and Sons, London, the dynamo being of the Elwell-Parker type, driven by a Marshall 8-h.p. vertical engine, with boiler, the whole being laid on thick beds of concrete. Cables are laid to supply light in the house, conservatory, the offices, and the stables. The number of lamps fixed is 134, eight and

16 c.p. The installation includes a storage battery of 53 cells. The agent, Mr. W. E. Frith, superintended the work. The installation is the first in this neighbourhood on so large a scale, and there is no doubt that others in the neighbourhood will follow the example.

Bradford Tramways.—Our readers will be glad to hear that the experiments undertaken by Messrs. Easton and Anderson, in conjunction with Mr. M. Holroyd Smith, on behalf of the Bradford Corporation, to demonstrate the efficiency of electric energy in propelling tramcars up steep hills, have been brought to a successful conclusion, and arrangements are now being made for the construction and equipment of two miles of line where the average rise in the total length is 1 in 24, the road in many places being as steep as 1 in 13·3. The Corporation has consented to allow the temporary overhead conductors used for the demonstration to remain in position for another fortnight, in order that gentlemen from other towns interested in tramways may witness the running of the car. Anyone desiring personally to inspect the tramcar and its working can obtain the necessary permission on application to the London office of Messrs. Easton and Anderson, Limited, 3, Whitehall place.

Lemberg Exhibition.—An international exhibition of building materials will be opened at Lemberg, under the auspices of His Excellency the Governor of Galicia, on the 30th August and closed on the 20th September, 1892. It will comprise all the materials falling within the province of the architectural line, as stone, bricks, marble, cement, lime, timber and iron, locksmith's work, forged goods, metals employed in architecture, roofs, carpenter's work, glass, asphalte, waterproofs, paints, lacquers, varnish, paper hangings, tapestry, water supplies, pumping apparatus, bathing contrivances, ventilators, lighting materials, sewers, lifts, arrangements for the extinguishing of fire, house telegraphs, telephones, special arrangements chiefly of a hygienic nature. The executive committee meets at Lemberg. A special jury will allot medals to the exhibitors, which will be put to the disposal of the committee by the Austro-Hungarian Government. Foreign parties interested in this exhibition and requiring information are requested to apply without delay to Mr. Arthur Gobeit, at Prague, Karolinenthal, the delegate appointed for abroad, who is also ready upon request to charge himself with the representation of the foreign exhibitors for the term of the exhibition.

Telegraphs Bill.—In the House of Lords on Thursday, the 23rd ult., the House went into committee on the Telegraphs Bill. An amendment by Viscount Midleton was rejected. Lord Balfour of Burleigh moved an amendment on Clause 6 preserving the jurisdiction of the Commissioners of Sewers in the City of London, and obviating the possibility of there being any difference between the local authority exercising the powers under the Bill and the local authority whose consent was necessary under the Electric Lighting Act, 1882. The amendment was agreed to, and the Bill passed through committee without further amendment. In the House of Commons, on Monday, on the order for the consideration of the Lords amendment to this Bill, Sir J. Lubbock said that this Bill had been very rapidly passed through its stages in that House. It in some respects affected the powers of the London County Council, which, however, had had no opportunity of considering it. The vice-chairman of the Council, on behalf, as he understood, of the Parliamentary Committee, objected to the measure. At the same time, he did not feel justified in endeavouring to throw out the Bill, but he hoped that in future measures affecting London a longer time would be allowed for consideration. Mr. Pickersgill objected, but on division the Lords' amendments were agreed to.

Electric Tricycles.—The desires of those cyclists of the *dolce far niente* type, who wish electricity to do for them what other and more vigorous (if more heated) devotees do with their legs, must have received a rude shock last week in the disappearance from the scene of the Vaughan-Sherrin battery and motor. Described by nearly every paper in London, and favourably reported on by no less an authority than Prof. S. P. Thompson, this iron-manganese battery and special motor yet does not seem to have sufficient solid qualities of efficiency and economy behind it to make it go—or rather to make the tricycle go—for the battery syndicate itself is gone—voluntarily wound up by the shareholders. Alas for our hopes—and we were promised a trip up the river in a primary battery launch driven on this plan! The cyclists must evidently wait: and when electricity is applied to this wonderful modern machine—the cycle—it should be rather in a kind of Ward Leonard arrangement, by which the cyclists should work calmly always at the same speed, and the torque and speed of machine should vary at the motor. This, and not the actual carrying of a battery to do all the work, might be working in the direction of greatest usefulness.

Society of Arts.—One of the scientifically social events of the year is always the *conversazione* of the Society of Arts, when professors, celebrities, and their wives and relations meet in almost ideal surroundings to exchange compliments, listen to the music, and inspect the treasures of art and science at the national museum of Great Britain. Wednesday's function was no exception to the universally successful gatherings of the society, and for hours distinguished throngs were received by Sir Philip Cunliffe Owen (in the absence of Sir Richard Webster), wandered round the galleries, listened to the Royal Engineers' band, the exquisite singing and playing of the Meistersingers, or promenaded on the grass in the quadrangle to the accompaniment of music by the Scots' Guards, electric light, and brilliant costumes. Amongst electrical celebrities present were Prof. S. P. Thompson, Prof. Perry, Mr. J. W. Swan, Mr. Garcke, Mr. Ferranti, Mr. Kapp, Mr. Webb, and a large number of others, bearers of well-known names. There were also present Lord Stanley, Sir H. Doulton, Prof. Dewey, and the members of the council. The whole of the courts and corridors of the ground floors were open, together with the galleries containing the Raphael cartoons, the Sheepshanks collection, the William Smith collection of water-colour drawings, the Dyce and Forster pictures, and the Chantrey Bequest, all brilliantly illuminated by the electric light, making a reception scene that is not easily forgotten.

Glover's Cables.—Messrs. Walter T. Glover and Co., the well known cable manufacturers of Salford, certainly are determined to advance with the times. We see it in every sign. No sooner do we hear of a patent steel flexible piping, than the firm use it for covering cables; no sooner do we require anti-induction wires than they bring them out—flexibles, concentrics, high insulation, waterproof insulation, cables for central stations, houses, ships, and mines—all are brought forward with just that amount of detail that installing engineers should be able to find exactly what they require. And now they have brought out their catalogue on a new plan, so that requirements shall be still easier to find. We much admire the ingenious way in which details and particulars of all kinds are given in such convenient compass—and the book is made up to be a really handsome work instead of a mere dry catalogue. There is a finger-index cut into the leaves to turn up any detail you want at

once, and, above all, the reference numbers are now all arranged on a capital plan, to such a manner that they really describe what they stand for. For instance, you want a $^{19}/_{21}$ vulcanised rubber cable for 2,000 volts, 750 to 100 megohms per mile. You find this in class 66, and you wire for a mile of "No. 192166"—nothing could be simpler. A number of new and useful tables are added, making it quite a useful work of reference. We advise every electrical engineer to procure a copy of Glover's catalogue.

Electric Cranes.—The Works Committee of the Southampton Town Council reported in regard to tenders on amended designs for electric cranes that they had received the following tenders for the supply of two electric cranes:

	Two cranes.	Accessories, mains, etc.	Total.
Keys' Electric Company...	£2,700	... £1,175	... £3,875
Crompton and Co.	3,209	... 234	... 3,443
Statter and Co.	2,150	... 237	... 2,387

Messrs. Statter and Co.'s tender was recommended for acceptance. The surveyor, Mr. J. G. Poole, reported that the estimated cost of strengthening the quay to take the proposed gantrys and cranes was £665. Councillor Bone moved the adoption of the report, and said that the result of the visit of the deputation to Hamburg showed that the Hamburg electric cranes were much superior to those they proposed to have on the pier. Messrs. Statter's was the lowest tender, as on a former occasion. The cranes were to be made by an English firm. The Corporation would have to spend £600 in strengthening the quay. The junior bailiff, as one of the deputation which went to Hamburg, seconded, and said that it was a happy consummation of what they had in hand since November, 1889. He believed that they had taken a step in the right direction, and when they had the cranes in six months' time the Harbour Board would be the first persons in the kingdom to use electric cranes on their premises. Now that the railway company had possession of the docks, he hoped that they too would see that it would be policy on their part to follow on the same lines. The report was unanimously adopted.

Ship Struck by Lightning.—The following detailed account of the effect of lightning on a ship's compass recently is extremely interesting, and is probably almost unique: "Captain Woodcock is master of the 'Capella,' a steel steamer of 2,036 tons net register, having two masts, the lower masts being of iron, the top masts of wood. The steel wire rigging (served over) is carried to within about 3ft. of the trucks, but there is no special lightning conductor fitted. Captain Woodcock reports the following incident on May 16, in latitude 28·12 N., longitude 70·50 E.: 'The morning was squally, with rain, and thunder, and lightning. About half-past seven the storm seemed to have passed over, and the weather showed signs of clearing up, when, after a considerable interval, there was a very vivid flash of lightning, accompanied by a violent explosion by the rail, near the starboard fore rigging, which seemed as if something had exploded and scattered sparks and fire over the ship. The foretopmast was splintered near the spire, and some service torn off the topgallant backstay. The shock also affected the compasses; that on the upper bridge was deflected from N. 72 W. to N. 45 W., and remained for a short time that way. The wheelhouse compass, which had previously shown W.N.W., now showed E.S.E., and the compass on the poop was considerably affected also. After trying another compass card in the wheelhouse, found the card was not affected, but the shock had changed the magnetism of the ship so much that it r[illegible] end. The westerly deviation of the upper bridge compass was later on found to be increased 9deg. W. to 19deg. W. on the course steered (N. 72deg. W.). At 4 p.m. swung the ship completely round, and found the errors of the compasses very much altered; the deviation on the north was altered from 6deg. W. to 27deg. W. It was found after the ship was turned round that the wheelhouse compass had regained some of its original power, as the north point again pointed somewhere towards the north. Since the occurrence the compasses have never regained their original errors, and the magnets have had to be moved and some reversed, to reduce the errors and make them easier to be applied.'"

Overhead Wires.—On Wednesday afternoon, Mr. Courtenay Boyle, on behalf of the Board of Trade, received a deputation from the Electrical Section of the London Chamber of Commerce with reference to proposed alterations in the clauses of the Overhead Wires Bill. The deputation was introduced by Sir Vincent Barrington. Major Flood Page explained that the Electrical Section had several objections to make to certain clauses of the Bill for the benefit of the telephone industry, which he hoped would be taken into consideration by the Board. Mr. Courtenay Boyle said that it was a little out of order to receive deputations after public discussion had taken place, but as the question was still open the Board had agreed to consider, and had already embodied, alterations which would cover many of the objections. The clauses were then gone into seriatim. The chief alterations embodied were that the companies should mark routes of wires and positions on a map, 25in. to the mile, supplied by the County Council, six months being allowed instead of three; new wires were to be marked one month after running instead of 14 days beforehand—a great concession; clause 3, with reference to previous consent for fixing poles, is taken out altogether; 6ft. is to be the height above roofs instead of 7ft., and the clause is to refer to future wires only; the limit of 140 yards span is altered to no limit, provided consent of Council and local authority be obtained; the clause with reference to angle of crossing of street comes out; modifications of the factor of safety clause are allowed; the wind pressure calculated for to be 35lb. per square foot instead of 50lb.; the company owning the support is to be responsible for wires and attachments to that support; clause 11 is struck out; the clause with reference to weight and diameter of wire is altered to read that the wire shall not exceed 1lb. per lineal foot, instead of yard, and no limitation is given as to diameter; the clause re prevention of oxidation of support is suitably modified; the clause about connection to earth is struck out; clause 19, with reference to disused supports, reads that no support is to be left after it has ceased to be of use "unless the company intend to put it into use again"—an enormous difference to the company. The chief objection, however, was to the right of compulsory access to houses by inspectors. Major Flood Page said that wayleaves were difficult enough to obtain now, and if a wayleave carried compulsory power to inspect, householders would simply refuse to grant wayleaves at all, and the telephone industry would enormously suffer. The danger was problematical—out of 700,000 accidents only two had been traced to overhead wires. He urged that the companies should only be asked to do their best to obtain leave of access. Mr. Courtenay Boyle said the clause provided for access at "reasonable" time after "reasonable" notice. The question had been fully discussed, and he could hold out small hope of the Board's altering the clause. He would, however, bring it before their notice. The deputation thanked him and then withdrew.

CENTRAL STATION AT OXFORD.

On Saturday, June 18, the formal ceremony of turning on the current by the Mayor of Oxford took place. A large and influential company were gathered together to witness the ceremony. Before, however, saying anything more of this festal gathering, it may be well to supply our readers with a slight history of the undertaking and a description of the equipment of the station.

FIG. 1. - Oxford Electric Company's Station at Osney.

The Electric Installation and Maintenance Company obtained two provisional orders at the same time --one for Oxford and one for the Crystal Palace district. Last August the company was reconstructed; the business of the original company being restricted to the carrying out of the Crystal Palace District order, while the Electric Construction Corporation took over the Oxford order, and have carried out the work, with the intention, however, of ultimately transferring it to a local company, formed and

FIG. 2. -Dynamo Room.—Osney Station.

entitled, "The Oxford Electric Company." An application was therefore made to the Board of Trade to transfer the provisional order, which application has been duly granted by Electric Lighting Order Confirmation Bill (No. 4). In the meantime, as Mr. J. Irving Courtenay (chairman of the Oxford Company) explained at the statutory meeting, the Oxford Company made an agreement with the Electric Construction Corporation to provide for the construction of a fully equipped generating station for the supply of electricity, together with all the necessary street works, mains, transformers, and storage batteries for the supply of the area with which it was first proposed to deal. This area comprises High street, Cornmarket-street, Broad-street, Magdalen street (from the corner of Beaumont-street to Cornmarket-street), and Catherine-street. In this area there are 12 colleges, 39 public buildings, and 337 shops, offices, and private houses. Provision was made in the contract for a supply sufficient for about 15,000 lamps. The system proposed was described as a moderate high-pressure continuous current of 1,000 volts, with continuous current transformers to convert to 100 volts, and secondary batteries to supply current to lamps during the hours of minimum demand, so that during this period the generating station might be entirely shut down. The high pressure current goes by underground mains to the distributing stations, the principal one being in Broad-street. Under this contract the Electric Construction Corporation entered into a sub-contract with Mr. Kingerlee, a well-known local builder and contractor, for the erection of the necessary buildings at Osney, the site being close to the water's edge and extremely convenient. The whole of the works have been carried out by the Electric Construction Corporation from the designs of Mr. Thomas Parker, who has had, as resident engineer, a most efficient assistant in Mr. W. H. MacLean, under whose immediate superintendence the whole plant has been fitted up. The works, as completed and opened on June 18, include the general-

ing station at Osney, where there is a battery of accumulators and motor-dynamo, in addition to the generating plant, and sub-stations have been established at 45, Broad-street, where there is a larger battery of accumulators and motor-dynamos, the other sub-stations being in King street and in Queen street, where also motor dynamos are fixed

Coming now to a description of the station and its equipment, Fig. 1, prepared from a photograph, shows the river front of the building, Fig. 2 shows the engine and dynamo-room. This room is furthest from the river,

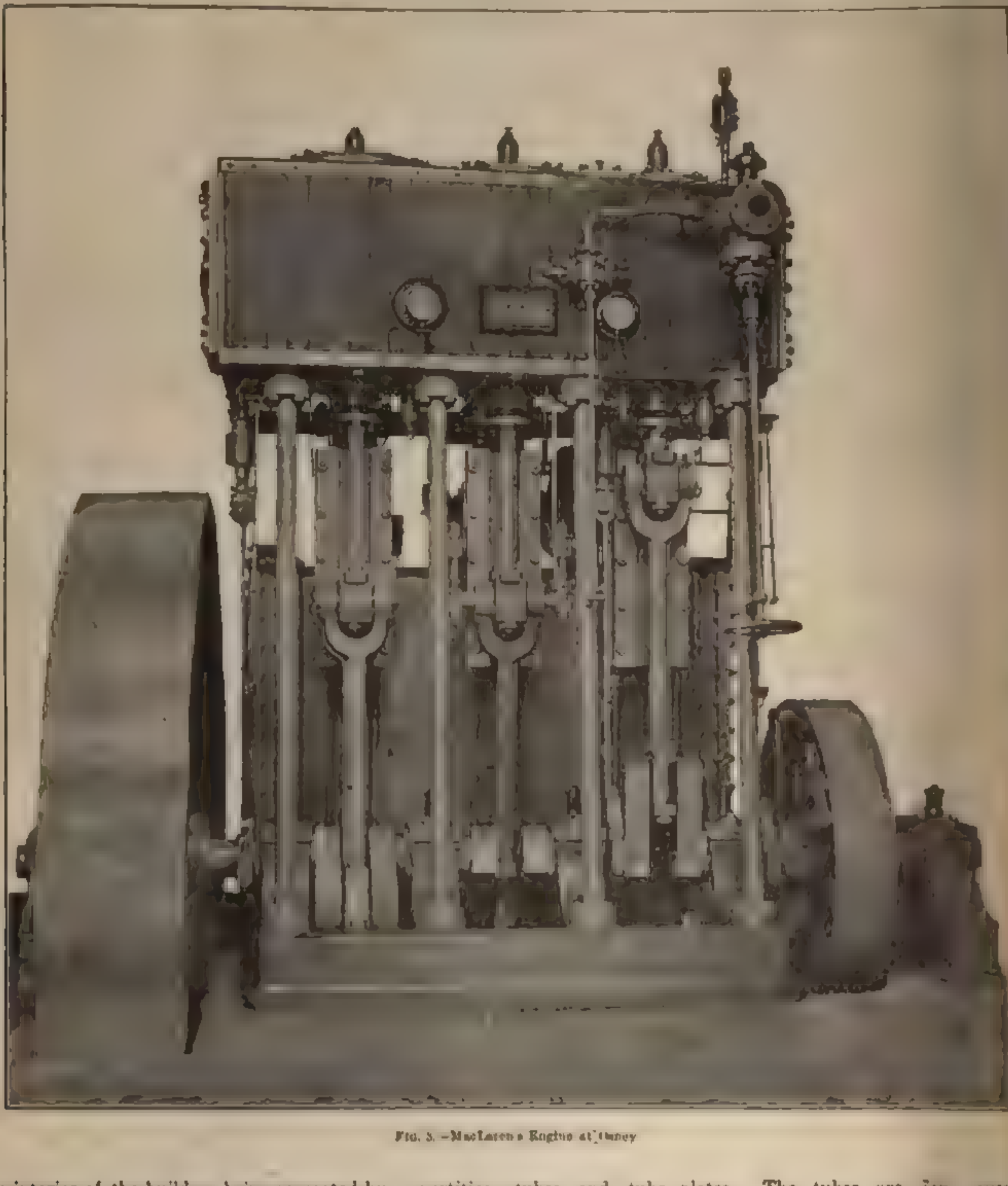


Fig. 3.—MacLaren's Engine at Osney

the interior of the building being separated by a partition wall seen behind the engines. The half of the building nearest the river front is devoted to boiler space, so that the fuel has to be moved through the shortest possible distance. The boilers and engines have been constructed by Messrs. J. and H. McLaren, of Leeds. The boilers are of the multitubular locomotive type, and are made of Siemens steel throughout, and with them is used a Green's economiser. The donkey pump is by Worthington.

The engines, Fig. 3, are of the vertical triple expansion with high pressure and intermediate cylinders d with steam at boiler pressure, and drained through a M'Dougall steam-trap into the hot-well The low pressure cylinder is not jacketed. The M'Laren automatic expansion governor works direct on to the high pressure slide valve, which is not balanced in any way. The governor being self locking is not affected by any friction on the slide valve. The steady running of the engines under very varying loads proves this governor to be all that could be desired, and being keyed on the crankshaft there is no fear of accident through the governor belt breaking or coming off The surface condenser is fitted with brass tubes and tube plates. The tubes are ⅝in. out diameter; cooling surface, 382 square feet; air-pu 11¼in. diameter by 14in. stroke; circulating pump, 10 diameter by 14in stroke; feed pump, 1½in. diameter 14in. stroke; all pumps placed behind the conde and worked by levers from the intermediate en crosshead. Clearances of cylinders are as follows · H pressure cylinder, top 117 cubic inches, bottom 161 di intermediate cylinder, top 237 cubic inches, bottom ditto; low pressure cylinder, top 482 cubic inches, bo 574 ditto, crankshaft, forged steel, 5½in. diameter, c pins 5½in. diameter, each bearing 9in. long, total leng

bearing surface of crankshaft 54in.; eccentric straps, wrought iron, lined with cast iron, eccentrics cast iron, all spindles $1\frac{3}{8}$in diameter, all wearing surfaces of ample area. The engines are very massive and substantial for the power

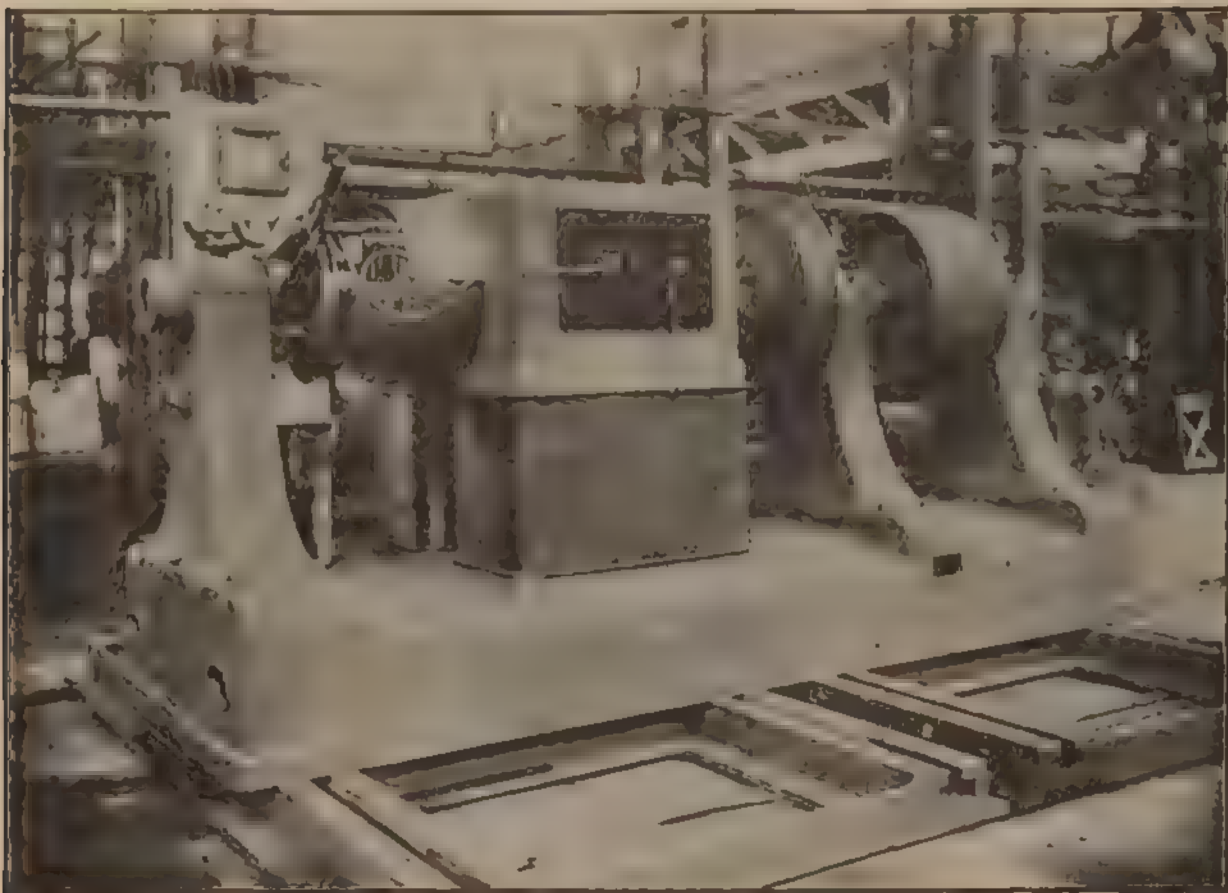


FIG. 4. Dynamo at Oxney.

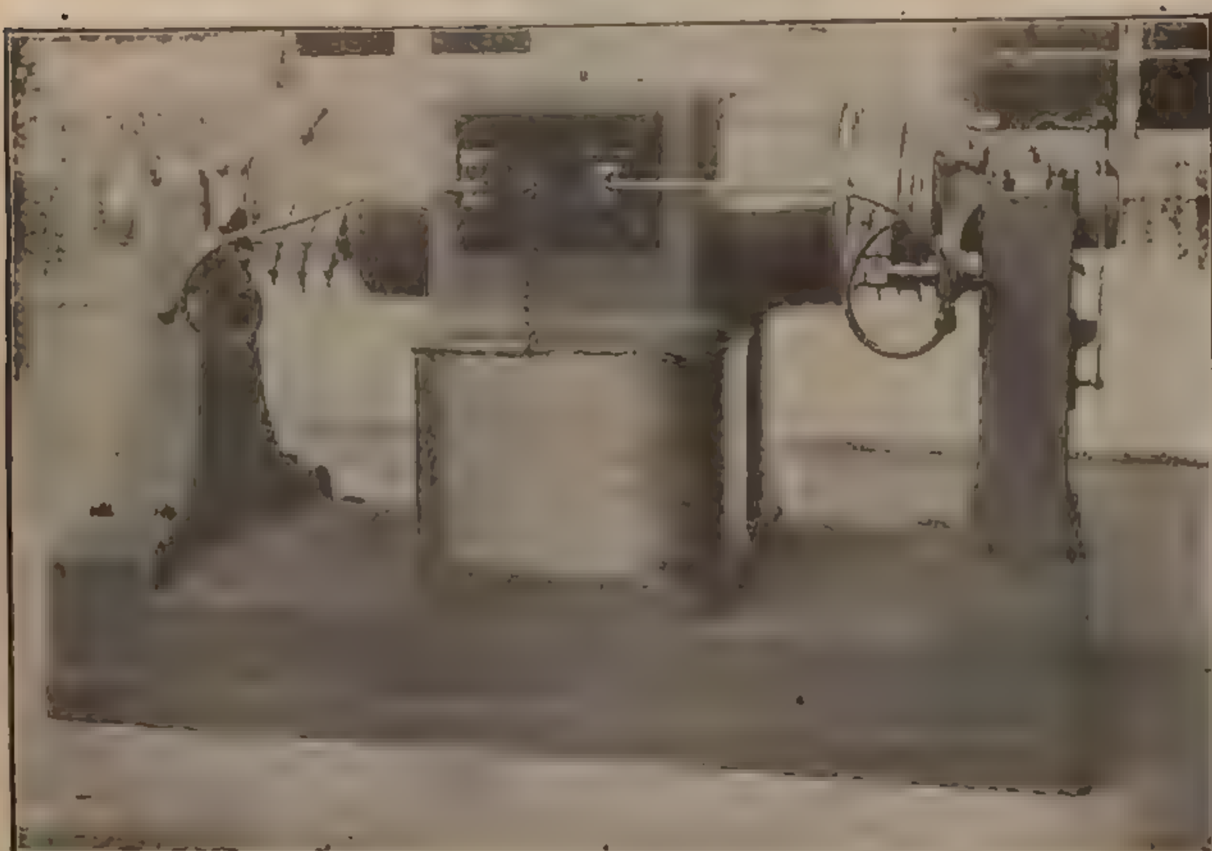


FIG. 5. Motor Dynamo at Oxney.

eccentric rod joints case-hardened and adjustable; piston-rods of steel, $2\frac{1}{4}$in. diameter; crossheads wrought iron, fitted with cast-iron slippers 96 square inches area, valve-

they require to develop. No expense has been spared in making these engines, so that it is expected they will work economically for many years without much cost for repairs

or tendency to breakdown. In addition to the foregoing information the builders have given the results of tests of these engines :

Type of engine	Inverted triple expansion	
Size of cylinders, h.p. 9in., m p. 14·25in. l p. 22·5in. by 24in. stroke		
Type of boiler	Locomotive	
Heating surface, fire box	116 sq. ft.	
Heating surface, tubes	764 sq. ft.	
Heating surface, total	880 sq. ft.	
Number of tubes	105	
Dimensions of tubes	11ft. 1½in. by 2¼in. outside diameter	
Material of tubes	Steel	
Dates of trial	19th Jan.	21st Jan.
Jackets	Not used.	Used
Duration of trial	245min.	240min.

Coal per square foot of grate area per hour	15·00	12·8	
Water evaporated per lb. of coal	10·18	10·11	
Water evaporated from 1 at 212deg. F.	11·84lb.	11·69lb.	
Average boiler pressure	153lb.	157·60lb.	Taken every 15 min.
Average height of water in glass	1·54in.	·84in.	Taken every 15 min.
Total No. of revolutions	31,263	29,020	
Revolutions per min.	127·6	121·6	
Circumference of brake	30·8ft.	30·8ft.	
Weight on brake	1,014lb.	946lb.	
Pull on spring balance	70lb.	4·77lb.	

FIG. 6. FIG. 7. FIG. 8.

Section of Underground Mains Laid at Oxford

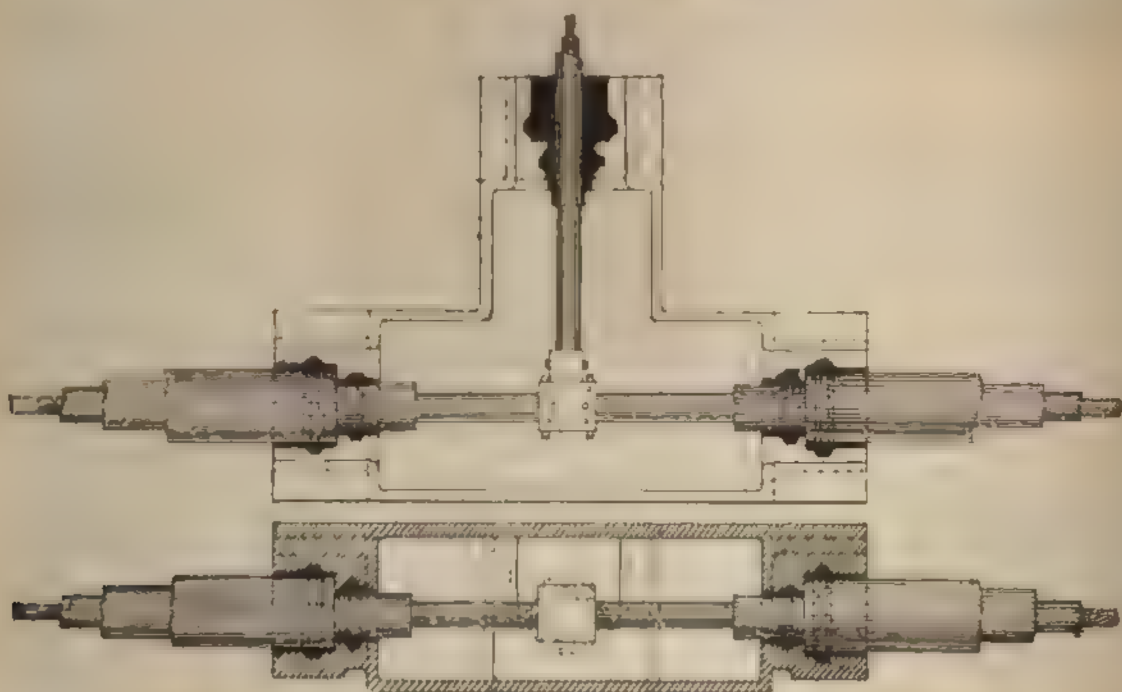


FIG. 9.—Arrangements for Connecting Branches and Services with Lead-Sheathed Mains.

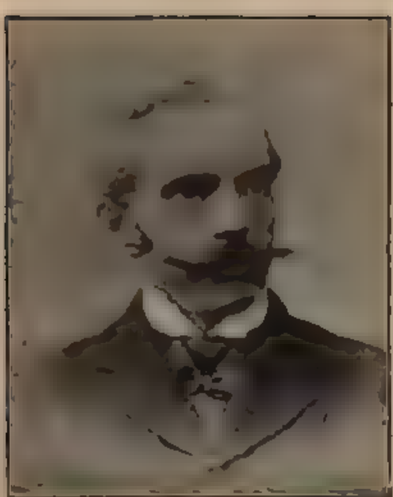
Grate area	28 sq. ft.		
„ During trial	13 sq. ft.		
Number of firebars	80	80	
Width of bars in inches	$\frac{5}{16}$in.	$\frac{5}{16}$in.	
Width of air spaces in inches	¼in.	¼in.	
Total heating surface to grate. Ratio	33·8	33·8	
Area through tubes	2·92 sq. ft.	2·92 sq. ft.	(ney) 23ft. high
Size of chimney	24in. diam.	24in. diam.	Temporary chim
Total water used during trial	8,133lb.	6,796·5lb.	From engine condenser 5776·5; Auxiliary 100; Jackets 620
Water per hour	1,992lb.	1,657·6lb.	
Total coal used	800lb.	672lb.	
Coal per hour	195·9lb.	163·8lb.	

Net load	944	941·23	
Brake h.p.	112·8	106·85	
Water per b.h.p. per hour	17·67lb.	15·513lb.	Including jackets
Coal per b.h.p. per hour	1·73lb.	1·534lb.	
I.H.P., high pressure	50·27	40·35	Richards' indicators used on 19th. Crosby's on 21st.
„ M. „	50·04	42·6	
„ Low „	44·9	39·48	
„ Total „	145·21	122·43	
Water per i.h.p.	13·7lb.	13·54lb.	Including jackets
Coal „	1·349lb.	1·330lb.	
Brake ratio	77·67 %	87·35 %	
Total condensing water	10,060galls.	9,695galls.	
Condensing water per hour	2,400galls.	2,365galls.	
Proportion of water to feed water	12·37 to 1	14·41 to 1	

DR. J. HOPKINSON.

DR. E. HOPKINSON.

W. J. HAMMER.



E. GARCKE.

A. R. BENNETT.

Temperature of hot-well	108deg. F.	95·18deg F	Taken every 15 minutes.
Temperature of feed-tub	102 5deg.	108·75deg.	Taken every 15 minutes.
Temperature of condensing water	37deg.	36deg.	T'ken three times during trial.
Temperature of discharge . .	111deg.	98·18deg.	Taken every 15 minutes.
Temperature of smoke box	474·7deg.	456·5deg.	Taken every 15 minutes.
Temperature of boiler house	63deg.	68deg.	T'ken three times
Temperature of engine-house	51deg.	56·5deg.	" "
Vacuum in condenser	27·5	27·98	Taken every 15 minutes.
Vacuum in smoke box	·13	·105	
Barometer . .	29·81	29·08	Taken twice.
Coal used, Ebbw Vale.			

The engines drive the dynamos by means of link leather belts, with centre steel links. The dynamos, Fig. 4, are direct current, giving an output of 1,080 volts, 80 amperes, at 400 revolutions The dynamos are fitted with extra bearing on the outside of the pulley, and are separately excited by three small continuous-current Elwell Parker dynamos, driven by rope gear from a pulley on the main shaft of the dynamos, as shown in the illustrations. The exciters are arranged to give 135 volts, so as to charge the accumulators used for lighting the central station. The pressure of the main dynamos may be regulated from 1,100

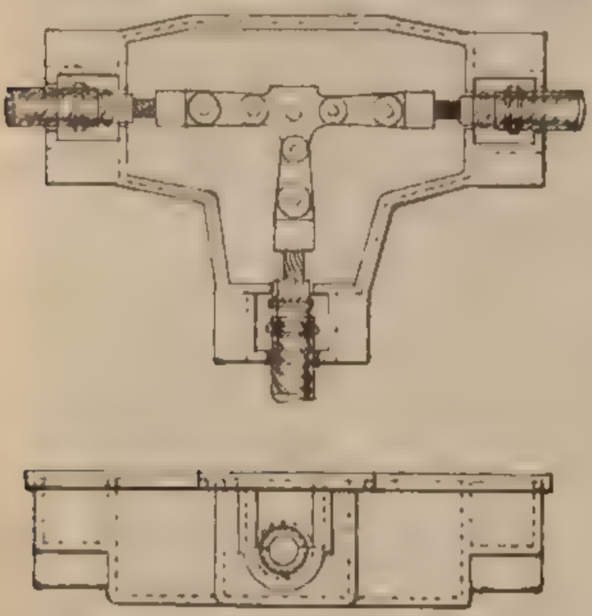


FIG. 10.—Disconnecting Box with Three Links.

volts at full load to 1,000 volts at light load, by means of resistances placed in circuit with the exciters. Each dynamo has in circuit an automatic cut out, which protects the dynamo in the event of any short circuit or excessive current. The cut-out is reset by hand. The main dynamos are coupled in parallel on to main omnibus bars, from which current is transmitted by means of two pairs of vulcanised cables drawn in iron pipes to the central switchboard in Broad-street, where another pair of omnibus bars receive the current. Fig. 5 shows the motor-dynamo, one of which is in the central station and others at the sub-stations. These motor-dynamos are all of the self starting type, and are similar to the one described in the machine department at the Crystal Palace. Briefly speaking, the machine is a double one, having two sets of armature windings, one receiving current from the generating high pressure dynamo and acting as a motor driving the other, which thus acts as a generator to feed the low-pressure supply, or distributing network.

The cables for the distributing network have been manufactured and laid by Callenders Bitumen, Telegraph, and Waterproof Company, Limited, under the supervision of their resident engineer, Mr. W. Douglas Reid The cables are of two sizes—viz., ½in. section and ¼in section and are of the lead-sheathed and armoured type, Figs. 6, 7, and 8, the armour consisting of two layers of steel tape. The cables are simply laid in a trench under the footway, at a depth of about 18in. They are laid in lengths varying from 150 to 200 yards, and are connected together in cast-iron joint-boxes, with copper connectors, Figs. 9 and 10. The box is then run in solid, with bitumenised wax compound. Disconnecting branch boxes are provided at different points in the network, so that any section or street can be cut out without in any way interrupting the supply to the other portion of the network. House services are laid on when required, the joints to the mains being made in T boxes, with T-copper connectors. These boxes and connectors are so made that the cable has not to be cut. The cable is simply bared down to the copper strand and the connector put on and soldered, and then the box is run in solid with bitumenised wax compound. The small service cables are of two sizes, $^7/_{14}$ and $^{10}/_{16}$, lead-sheathed and armoured.

The arc light cables are also $^7/_{16}$, lead-sheathed and armoured.

(To be continued.)

THE OPENING CEREMONIAL.

Thus far, then, our description of the Oxford central station, which, as we have said, was formally opened on June 18. On that day, at the invitation of the directors, a large company assembled, and at half-past six sat down to dinner, which was laid in the dynamo-room. At the conclusion of the dinner

The **Chairman** (Mr. J. Irving Courtenay) welcomed the guests at that interesting stage of this great enterprise, and in suitable terms gave the loyal toasts.

Mr J. S. Balfour, M P., proposed prosperity to Oxford, pointing out that Oxford belonged to England as a whole in its past, in its present, and in its future; and the ceremony of that evening would show that Oxford, in matters of progress, was keeping fully abreast with the spirit of the times.

The **Mayor of Oxford** (Mr. Ansell) replied, stating that they were blessed with over 20 corporate bodies in Oxford, and, as a rule, corporate bodies were very slow to move in any new path. It might be surprising to some of the guests to know that the gas company - although one of the oldest in England - had not even yet obtained the introduction of its manufactures into the college rooms. He pointed out that in Japan the new illuminant was seen by him during his stay at Kyote the old capital at a new theatre which had just been finished there, and he trusted that as they had a very pretty theatre in Oxford, the management would move with the times and provide it with the electric light. On behalf of the Corporation, he would say that they were animated with one object - to promote the prosperity of the city.

Sir Henry Acland then replied for the University of Oxford. He could not understand why he was called upon to make this reply, but suggested that he had one qualification, that of age, which ought to give him experience. His experience was somewhat curious. When he first came to Oxford, he travelled outside a coach from Exeter. When he returned home he went by rail in 4¼ hours. He had seen the telegraph invented and come into universal use, also the telephone; but there seemed one great want in this city the adoption of the new illuminant.

Mr Louis A. S. Bigge also responded, and then the **Chairman** announced that the Mayor would switch on the light, which was done amid great applause.

Alderman Buckell proposed "Prosperity to the Oxford Electric Company. He was glad to find Oxford in the van in the march of improvement. He thought the toast was deserving of approval, and the company was deserving of support, and that the light which was brought to their doors should be taken advantage of by every man of enterprise in the city. Referring to the manager (Mr. Offen), he came into Oxford comparatively a stranger, and by his courtesy and perseverance had won hosts of friends.

The **Chairman**, in reply, said he thought it was a subject for congratulation that the works had reached their present complete condition with so few hitches or serious delays of any kind. The fact was that the business of supplying electricity had now passed its experimental stage, and had reached a development that there was little or no practical difficulty in furnishing a city with a supply of electrical energy, which could be used for the purposes of lighting, power, or traction, or even of cooking, of which they had had illustrations presented to them that evening. The finishing of the buildings, and the fitting and installing of the plant and machinery, not only in the building in which they were, but in the sub-stations, so that the supply of light could now be furnished as promised, was very creditable to Mr. Parker and all those who as members of the staff were in their several departments responsible for this desired result. The extent to which electricity could be made available for the daily use of the people was not, he thought, sufficiently appreciated in this country, and he thought it was a mistake to suppose even in the present comparatively early development of this new industry that it was an expensive luxury It would be found in the long run, where it was intelligently used, and when all the circumstances were taken into consideration, to be as nearly economical a form of illumination as anything else, and when compared with gas it had undoubtedly marked advantages if they took into consideration the questions of health and convenience, and above all of safety He

believed there was an immense future for it in the direction of motive power. But in a city like Oxford the employment of the electric light was a matter of supreme importance. The Bodleian Library could now be used in the evening by the employment of this absolutely safe light, and also in foggy weather, a light which would not injure the books or any works of art. Then the Sheldonian Theatre could be utilised by night as well as in the daytime for the giving of concerts, which now had to be given only during daylight. There were many other developments which he might easily adduce, such as in the launches they had seen that day on the River Thames, and nothing could be better than that station on its banks for the supply of the motive power. They had to thank the Corporation for arranging with the company to test the lighting of the streets by electricity. Well lighted streets were a necessity of modern times, and although they commenced with a few lamps he hoped that within a short time the city of Oxford would be able to boast of the best public lighting in the kingdom. The enterprise had been carried out without any public subscription of capital, but with the ultimate intention of giving the inhabitants an opportunity of acquiring it either as a Corporation property or as a private local enterprise. He thought all enterprises of this kind should be local undertakings, and there was every reason why the supplying of electricity should afford a profitable means of investing capital when conducted under sound local business management, aided by experts who possess special knowledge of the subject. He was sorry to say that many of their friends had had to go away and catch their trains, among them Mr. Parker, their chief engineer, who had been coupled to respond to the toast, but he had put into his hands the remarks which he had proposed to make, and with their permission he would read them.

Mr. Parker referred in detail to the choice of that site for the works, which was a suitable one for many reasons. The system was required to be continuous current with a view to having a reserve of power in accumulation, and the site being a considerable distance from the provisional area it was necessary on the score of economy, and to make use of the station for reaching over the whole area of probable lighting, to use high-tension currents. The tension selected was 1,000 volts, with a range of sufficient increase to manipulate the voltage as the load was taken on and off the mains, varying to 10 per cent., so that the voltage at the station would at no time exceed 1,100 volts, whilst the voltage on the network from which the consumers' current was taken would be in all cases 100 volts, varying within the limits allowed by the Board of Trade. The system as a whole had been passed by the Board of Trade. They had secured a very high efficiency and reliability in the transformers, and had carefully worked out and patented means of handling them with the same precision and attention a mile away from the station as though they were in the station and under the eye and care of the attendant, thereby securing the least cost of superintendence of the system. This power of the management of the transformers enabled them to manipulate with continuous currents and a very high economy a large area of supply from one single station, therefore the station might be increased to the full requirements of the town, as was now carried out in the ordinary gas supply. The transformers were run in parallel with the accumulators, or run independently upon the consumers network by themselves. The economy of the transformers being 92 per cent. at full load, and not falling below 82 per cent. at one third load, and being at all times under the command of the attendant in the station where the manipulation of the whole system was carried out, the attendant was enabled to cut out or put in any of the transformers where the voltage indicated current was required, thereby securing that no energy was wasted at any part of the system, and that the whole system or any part of it was with the highest possible efficiency, the batteries situated in the centre of the provisional district at the controlling station being sufficient to carry out the lighting at any point of the district for the short hours, thereby enabling the central station to cease running when the batteries were capable of doing the lighting. The buildings had been put down with a careful view to the extension of the station up to a capacity of 30,000 running lights, and he was pleased to be able to pay their architect, Mr. Brevitt, of Wolverhampton, and the builder, Mr. Kingerlee, of Oxford, a compliment upon their design, cost, and execution. The boilers were chosen to give the highest evaporative efficiency, and the engines were slow speed, triple expansion, condensing, indicating 120 h.p., and of the highest class of manufacture. The dynamos run at a speed of 400 revolutions, and are well over their normal work, so that at any pinch they might be able to stand the higher portion of the supply curve without risk if it exceeded the estimated output by 25 per cent. In the electrical part all had been constructed with the greatest care to durability and efficiency, and for the development necessary to meet the demands of extension, which they confidently anticipated, so that they did not claim that the station, or means, or arrangement was designed to do its best work upon the present capacity, but whilst it would do its work upon the capacity as now arranged with high economy, it would be much more economical, and show its greater advantages as the station became extended. He estimated it no small honour to have had the opportunity of laying out and putting to work the lighting station of Oxford, and felt sure that the Oxford people would not be slow to appreciate the advantages of the electric light, both in its aspect as an improver of healthy conditions in their dwellings, reducing fire risk, and in its cleanliness and adaptability to artistic effect.

Mr. Henry Mance proposed the health of "The Visitors," to which **Mr. Soutter** replied.

Councillor James proposed the health of "The Chairman," who replied, and the proceedings terminated.

TESTS OF TWO 6,500 WATT WESTINGHOUSE TRANSFORMERS.

Before giving any results of the tests I have made with your transformers, it will be well to explain the methods of experiment adopted.

The instantaneous value at any epoch in the period of the difference of potential between any two points of a circuit in which the potential difference is varied periodically, is made effective on the measuring instrument by means of a rotating contact maker attached to the shaft of the alternate-current generator. This contact maker was constructed for the King's College laboratory by Messrs. Siemens Bros.; it makes contact once in each revolution for a period of about ½deg., and breaks it for the rest of the revolution. It is entirely insulated, and so can be connected to any part of any circuit. The position of the contact can be varied, and the variations be read off on a graduated circle of 3½in. diameter divided into degrees, and by estimation the variation can be read to one-tenth of a degree.

The two points between which it is desired to measure a potential difference are connected through the contact maker to a condenser and quadrant electrometer, as shown in Fig. 1, in which A and B are the points the potential difference of which, at a stated epoch, is to be measured, C the revolving contact maker, D the reversing switch of the electrometer, E the condenser, of which the capacity can be varied, F the quadrant electrometer. It is evident that the quadrant electrometer will give a reading proportional to the potential difference of A and B when C makes contact. If there were no leakage, it would at once give this potential. It is to obviate the effect of leakage that the condenser is introduced, and the amount of the effect was determined by varying the condenser: thus, when the condenser had capacity 1, 0·5, and 0·2 microfarads, the reading of the electrometer for a given potential difference of an alternating current at the position in the period of maximum E.M.F. were 138, 136, and 132 respectively. The rate of loss of potential will be proportional to the reciprocal of the capacity, whence we at once infer that the true reading, if insulation were perfect, would be 139½, and hence the readings are always corrected by adding 1 per cent.

When the potential difference was too great for the electrometer it was reduced in any desired ratio by two considerable resistances introduced between the points to be measured in the usual way, Fig. 2.

The potential difference may, of course, be measured in other ways. An ordinary voltmeter may be placed between A and B, in which case it must be standardised with the contact breaker in circuit, and it will depend for its constant on the duration of the contact, which may vary; further, it gives, not the difference of potential at any definite epoch, but the mean difference of the whole time of the contact. The condenser may be used, and its potential measured by discharge through a galvanometer; this is open to the objection that if there be any leakage the result will depend on the time at which the contact is broken by the condenser key in relation to the time at which it was made by the revolving contact maker. Lastly, a Clark cell may be used, by a method which Major Cardew pointed out to me, as shown in Fig. 3, the resistances being adjusted until there is no deflection. This is open to the same objection as the first—namely, that it gives the mean of the potential differences which occur during the contact.

By making use of the first-mentioned method, we have the means of measuring accurately any potential difference at any epoch of the period, and of knowing the epoch.

For these experiments two transformers intended to be identical were available, each transforming between 2,400 and 100 volts. It was most convenient, on account of the resistance available, to couple these transformers up from 100 to 2,400 in the first, or No. 1 transformer, then down from 2,400 to 100 in the second, or No. 2 transformer, and to take up the energy from the second in a non-inductive resistance. The arrangement is shown in Fig. 4.

The obvious way of determining the efficiency of the combination would be to measure at various epochs of a half period the potential differences of the terminals of the machine and the current passing to No. 1 transformer, in like manner at the same epochs to measure either the potential differences or the current passing to the non-inductive resistance, thence to deduce the power supplied to the first transformer and taken from the second. This would be open to certain objections; we are comparing two nearly equal magnitudes, and desire their ratio, the ratio will be affected with the full error arising from an error in the determination of either magnitude, and such errors may be material, as the observations are not simultaneous, and conditions may change between one series of observations and another. These objections are avoided by the method adopted. The current from No. 2 is observed at certain epochs, the difference of currents between No. 2 and No. 1, and the difference of potential difference of No. 2 and No. 1 at the same epochs. These give the currents and potentials of No. 1 at the same epochs as the corresponding determinations of No. 2, and the differences will only be affected with the proportion of error of those differences. For example, suppose the efficiency of the combination were 90 per cent., and the possible error of determination of power 1 per cent., our result might be anything from 88 to 92 per cent. if made in the obvious way, but if made by differences the maximum loss would be 10·1 per cent., and the possible least determination of the efficiency would be 89·8 per cent. The method is essentially similar to the method I described* and subsequently used for testing

* *Proceedings* of the Institute of Civil Engineers, vol. lxxxvii., p. 235, and *Transactions* of the Royal Society, part I., p. 347 (1886.

dynamos. The measurements are made as follows: for difference of potential differences, Fig. 5; for current difference, Fig. 6, where G is a small non-inductive resistance. The two currents will of course slightly disturb each other, but this is readily allowed for in the calculations.

Another method would be to couple them as shown in Fig. 7, G1, G2 being equal non-inductive resistances. This arrangement is quite free from disturbance, but requires two resistances adjusted to exact equality. A single transformer can be tested in he same way, though in this case reliance must be placed upon resistances to reduce the current of the low-potential coil, and to reduce the potential of the high-potential coil in the ratio of the number of windings in the two coils.

The current was throughout generated by a Siemens alternator with 12 magnets, run at a speed between 830 and 840 revolutions per minute, which gives a frequency of 5,000 per minute, or 83 to 84 per second.

The first experiment tried* was with the two transformers coupled, but with No. 2 transformer on open circuit, or on nearly open circuit, for a high resistance for purposes of measurement was interposed between the terminals of the low-resistance coil of No. 2 transformer. The actual results are given in Table I., and are expressed in Curve I. Tables II., III., and IV. give the results for half power, nearly full power, and full power, and the sets of curves of corresponding numbers give the results of the tables. In these tables the first column gives the position of the contact brush in degrees, so that 60 on this scale corresponds with a complete cycle. Three degrees are thus $\frac{1}{83 \cdot 3 \times 20}$ of a second. The second column of No. 1 table is the current in the thick coil of No. 1 transformer, as determined by the difference of potential at the two ends of a non-inductive resistance in which the current passes. The third column is the potential difference of No. 2 transformer, a direct determination. The fourth column is solely for the purpose of determining the square root of the mean of the squares of the third column. The fifth column is a direct determination of the difference of potential of 1 and 2, obtained in the manner explained with reference to Fig. 5. The sixth column is the deduced potential difference of the terminals of the thick wire of No. 1 transformer, being the sum of the third and fifth columns. The seventh column, like the fourth, is merely for the purpose of determining the square root of the mean of the squares of column six, whilst the eighth gives the rate at which power is given out by or received by the pair of transformers.

If the transformers had been exactly equal, the potentials for the two given by Table I. would have been equal, though they would have differed a little in phase, owing to the lines of magnetic induction which pass through the non-magnetic space between the two coils of the transformer.

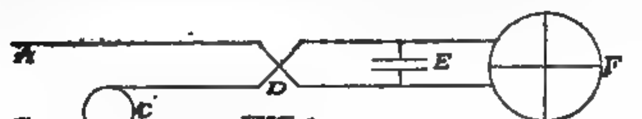


FIG 1

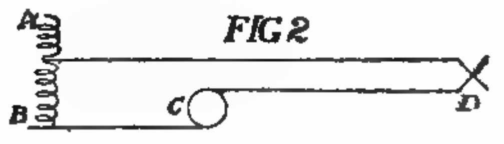


FIG 2

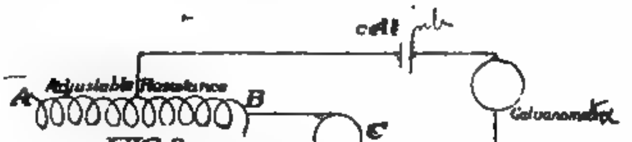
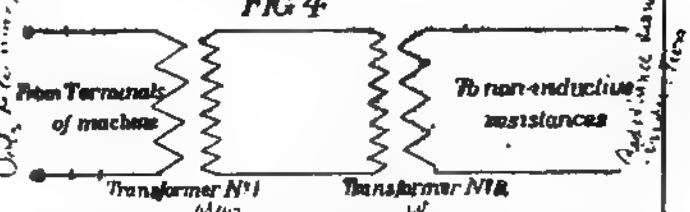


FIG 3

FIG 4



The difference shows that No. 1 transformer has a ratio of transformation slightly greater than No. 2. If we correct the potential of either No. 1 or No. 2, there still remains a difference between them, but this difference will be the greatest about when the potentials are nil. This is due to the lost induction just referred to.† In order to check the conclusion that the two transformers are not precisely equal, they were directly compared as shown in Fig. 8.

Table I.

Leads of exploring brush on divided circle.	Current No. 1. Thick coil. Amperes.	Potential No. 2. Thick coil. Volts.	Potential No. 2. Thick coil. Square of volts $\sqrt{mean^2} = 101 \cdot 1$.	Potential No. 1. Thick coil. P.D. Sec. Nos. 1 and 2. Volts.	Potential No. 1. Thick coil. Volts.	Square of volts $\sqrt{mean^2} = 101 \cdot 9$.	Watts supplied to No. 1.
267	−2·2	+ 25·4	645	+0·9	+ 26·3	692	− 57·9
270	−0·3	+ 70·2	4,928	+1·2	+ 71·4	5,098	− 21·4
273	+1·1	+ 95·3	9,082	+1·1	+ 96·4	9,292	+106·0
276	+2·1	+120·4	14,496	+1·1	+121·5	14,761	+255·1
279	+2·8	+147·7	21,816	+1·1	+148·8	22,140	+416·6
282	+3·2	+147·2	21,668	+0·9	+148·1	21,935	+473·9
285	+3·4	+119·8	14,351	+0·7	+120·5	14,520	+409·7
288	+3·5	+ 97·8	9,565	+0·6	+ 98·4	9,683	+344·4
291	+3·7	+ 71·3	5,084	+0·4	+ 71·7	5,140	+260·3
294	+3·5	+ 26·0	676	+0·3	+ 25·97	674	+ 90·9
—	—	—	102,311	—	—	103,935	2,282·6

FIG 5

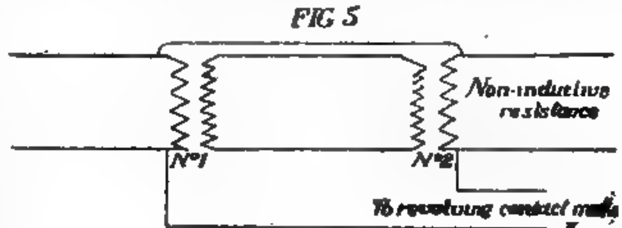


FIG 6

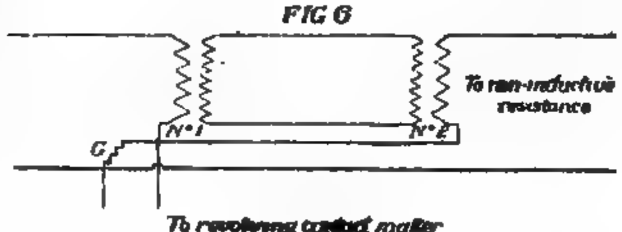


FIG 7

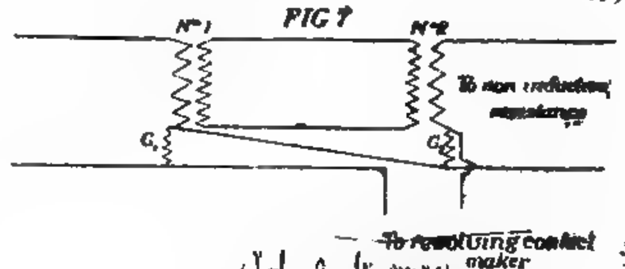
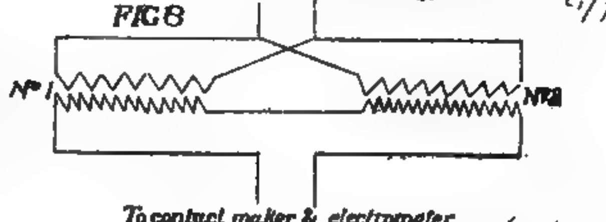


FIG 8



The transformers were coupled parallel, as in Fig. 8, and the difference of potential of the two high-potential coils was measured: the value of its square root of mean square was 12·5 volts, the potential of transformer being 2,400. This does not necessarily imply that the potentials of the two transformers differ by ½ per cent.: it may be largely due to a difference of phase between the two.

The current supplied to the No. 1 transformer is to be accounted for by the currents necessary to magnetise the two transformers, and by the local currents in their cores. To ascertain the former, the curve of magnetisation of one of the transformers was determined by the ballistic galvanometer for nearly the same induction, as in Table I. The changes of current supplied by a battery being

* So far as I know the first discussion of endless magnetic circuit transformers, based on the actual properties of the material, is in a note by myself (*Proc.* Royal Society, vol xlii.). Definite results were obtained by methods generally similar to those now used by Mr. Ryan. The theory of transformers is well set forth by Prof. Fleming.

† Prof. Perry has already pointed out that the effect of such lost induction cannot be entirely neglected even in endless-circuit transformers.

TABLE II.

Current No. 2. Thick coil. Observed deflection.	Current No. 2. Corrected deflection.	Current No. 2. Amperes.	Current No. 1. Thick coil. Current difference. Thick coils, Nos. 1 and 2. Observed deflection.	Corrected deflection.	Volts.	Amperes.	Current No. 1. Amperes.	Mean of current in Nos. 1 and 2. Thick coils.	Potential No. 2. Thick coil. Volts.	Square of volts $\sqrt{mean^2} = 104$.	Potential difference No. 1. Thick coil. P.D. Thick coils, Nos. 1 and 2. Observed deflection.	Corrected deflection.	Volts.	Volts.	Square of volts $\sqrt{mean^2} = 107 \cdot 4$.	Mean of potential in Nos. 1 and 2 Thick coils.	Watts supplied to No. 1.	Watts given out by No. 2.	Loss by resistance, and probably waste field. Resistance.	Losses unaccounted for, probably waste field.	Loss by hysteresis and local currents.	Difference of potential due to waste field.
2·5	2·5	+ 0·6	189·5	189	+3·7	– 2·9	– 2·3	– 0·8	+ 5·6	31	315	308	+18·2	+ 23·8	566	+ 14·7	– 55	+ 3	0·02	– 14·62	– 42·6	[illegible]
55	65	+16·0	77	77	+1·6	– 1·2	+14·8	+15·4	+ 51·9	2,694	278	273	+16·1	+ 68	4,624	+ 60	+1006	+ 830	8·7	+239·2	– 72	[illegible]
08·5	108·5	+26·7	28	28	– 0·6	+0·4	+27 1	+26·9	+ 83 6	6,989	196·5	195	+11·5	+ 95·1	9,044	+ 89·3	+2577	+2232	26·6	+282·7	+ 35·7	[illegible]
45	145	+35·6	99	99	– 1·9	+1·5	+37·1	+36·3	+110·3	12,166	99	197·2	+11·6	+121·9	14,860	+116·1	+4523	+3927	48·5	+372·5	+174·1	[illegible]
36	186	+45·7	152·5	152 5	– 3·0	+2·4	+48·1	+46·9	+141·1	19,910	203	201·2	+11·9	+153	23 408	+147·1	+7359	+6448	80·9	+477·2	+353	[illegible]
05	203·9	+49·9	186	186	– 3·7	+2·9	+52·8	+51·3	+153·6	23,592	61	61	+ 3 6	+157·2	24,710	+155·4	+8300	+7665	96·8	+ 87·9	+460·6	[illegible]
34	184	+45·2	203	201·2	– 4·0	+3·1	+48·3	+46·7	+138·5	19,181	73	73	– 4·3	+134·2	18,009	+136 3	+6482	+6260	80·3	– 281·3	+422·5	[illegible]
54	154	+37·8	220	[illegible]	– 4·3	+3·4	+41·2	+39·5	+114·9	13,202	75	75	4·4	+110·5	12,210	+112·7	+4552	+4343	57 5	– 231·3	+383	[illegible]
23	123	+30·2	238·5	235·5	– 4·6	+3 6	+33·8	+32·0	+ 90·6	8,208	126·5	126·5	– 7·5	+ 83·1	6,904	+ 86·9	+2808	+2376	37·7	– 277·7	+312·8	[illegible]
67·7	67·7	+16·6	237	234	– 4·6	+2·6	+20·2	+18·4	+ 47·7	2,275	252	248·5	– 14·7	+ 33	1,089	+ 40·3	+ 666	+ 792	12·5	– 283	+145·1	[illegible]
										108247					115424		38218	35236	449·5	371·6	2162·4	
																	92·2%					
																	298·2			298·3		

TABLE III.

Current No. 2. thick coil. Amperes.	Current No. 1. Thick coil. Current difference. Secondaries, Nos 1 & 2. Amperes.	Current No. 1. Amperes.	Mean of current in Nos. 1 and 2. Thick coils.	Potential No. 2. Thick coil. Volts.	Square volts $\sqrt{mean^2} = 98 \cdot 2$	Potential difference. No. 1. Thick coil. Potential difference. Thick coils. Nos 1 and 2. Volts.	Volts.	Square volts $\sqrt{mean^2} = 104 \cdot 3$.	Mean of potential in Nos. 1 and 2. Thick coils.	Watts supplied to No. 1.	Watts given out by No. 2.	Loss by resistance, and probably waste field. Resistance.	Losses unaccounted for, probably waste field.	Loss by hysteresis and local currents.	Difference of potential due to waste field.
–15	3 1	– 18·1	–16·5	– 20 6	[illegible]	+31·2	+ 10·6	112	– 5·0	– 192	+ 309	10·4	– 525·1	+ 15·5	+31·8
+15	– 1·6	+13·4	+14·2	+ 26·5	702	+29·7	+ 56·2	3,305	+ 41·3	+ 753	+ 397	7·6	+ 414·1	– 66·1	+29·2
+38·5	– 0·2	+38·3	+38·4	+ 63	3,969	+22·7	+ 85 7	7,345	+ 74·3	+ 3,282	+ 2,425	55·9	+ 815·7	– 14·9	+21·2
+57·1	+1	+58·1	+57·6	+ 91·8	8,427	+21 7	+113·5	12,880	+102·6	+ 6,595	+ 5,242	185·7	+ 1124·3	+102·6	+19·5
+75·2	+1·9	+77·1	+76·1	+120·2	14,440	+22·2	+142 4	20,280	+131·3	+ 10,980	+ 9 038	219·4	+ 1470·1	+249·5	+19·3
+88·8	+2·5	+91·3	+90	+141·6	20,050	+11	+152 6	23 285	+147·1	+ 13,930	+ 12,575	307·0	+ 683	+367·7	+ 7·6
+86·9	+2·8	+89·7	+88·3	+138·1	19,070	– 2·3	+135·8	18,440	+136·9	+ 12,180	+ 12,000	[illegible]	– 498·5	+383·3	– 5·7
+77·5	+3·1	+80·6	+79	+122·4	14,980	– 6·2	+116·2	13,502	+119·3	+ 9,365	+ 9,486	236·4	– 726·2	+369·8	– 9·2
+64·6	+3·4	+68	+66·3	+101	10,200	–11·8	+ 89·2	7,957	+ 95·1	+ 6,066	+ 6,524	166·5	– 948·8	+323·3	–14·3
+42·9	+3 5	+46·4	+44·6	+ 65·5	4,290	– 24·2	+ 41·3	1,705	+ [illegible]·4	+ 1,916	+ 2,810	75·4	– 1154·6	+186·9	–25·9
					96,552			108,811		64,875	60,806	1499·7	654·0	1917·6	
										93·73%					
										406·9			407·1		

TABLE IV.

Current No. 2. Thick coil. Observed deflection.	Current No. 2. Corrected deflection.	Current No. 2. Amperes.	Current No. 1. Thick coil. Current differences. Thick coils, Nos. 1 and 2. Observed deflection.	Corrected deflection.	Volts.	Amperes.	Current No. 1. Amperes.	Mean of current in Nos. 1 and 2. Thick coils.	Potential No. 2. Thick coil. Volts.	Square of volts $\sqrt{mean^2} = 80 \cdot 9$.	Potential No. 1. Thick coil. P.D. Thick coils Nos. 1 and 2. Observed deflection.	Corrected deflection.	Volts.	Volts.	Square of volts $\sqrt{mean^2} = 88 \cdot 4$.	Mean of potential in Nos. 1 and 2. Thick coils.	Watts supplied to No. 1.	Watts given out by No. 2.	Losses by resistance, and probably waste field. Resistance.	Unaccounted for, probably waste field.	Loss by hysteresis and local currents.	Difference of potential due to waste field.
59	59	+14·3	107	107	+2·1	–1·7	+ 12·6	+ 13·4	+ 21·3	454	355	345	+33·9	+ 55·2	3,047	38·3	695	304	6·8	+ 447·5	– 65·1	[illegible]
256	252	+61	57	57	–1·1	+0·9	+ 61·9	+ 61·4	+ 80·7	6,512	256	252	+24 8	+105·5	11,130	93·1	6,530	4,923	142·8	+1380·2	+ 83·8	[illegible]
427	410	+99·3	147	147	– 2·9	+2·3	+101 6	+100·4	+130·2	16,950	142	142	+14	144·2	20,790	137·2	14,650	12,928	382	+1023·5	+315·5	[illegible]
[illegible]	369	+89 3	188	187	3·7	+2·9	+ 92·2	+ 90·8	+116·1	13,480	59	[illegible]	– 5·8	+110·3	12,165	113·2	10,170	10,367	312·3	– 839	+320 3	[illegible]
[illegible]	[illegible]	+49·6	211	209	– 4·1	+3·2	+ 52·8	+ 56·2	+ 62·4	3,893	266	262	– 25·8	+ 36·6	1,340	49 5	1,933	3,095	99·3	– 1420·3	+ 158·4	[illegible]
										41,289					48,472		33,978	31,617	943·2	591·9	880·9	
																	93·05%					
																	472·2			471·2		

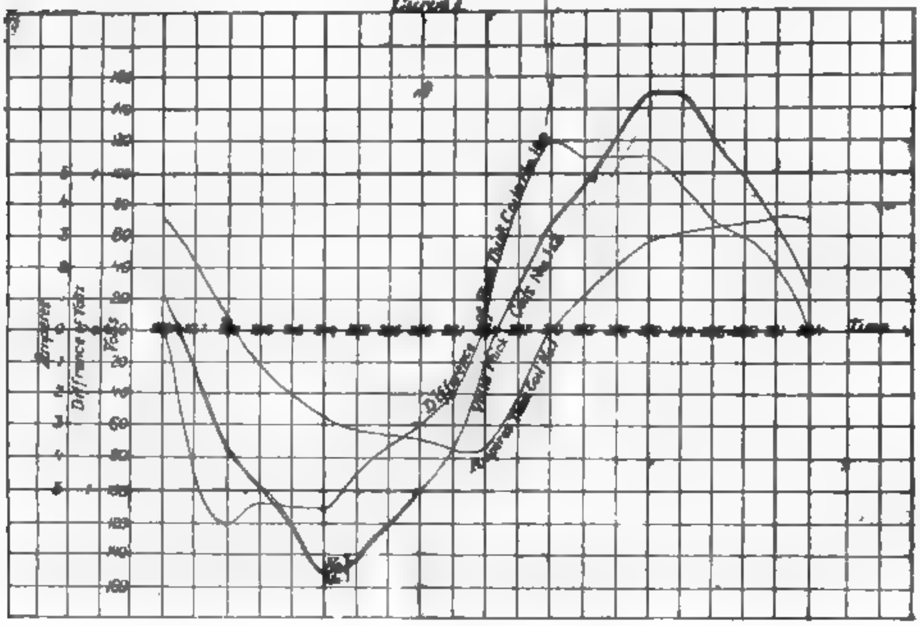
made by a reversing switch, or by suddenly introducing resistance into the primary circuit, and the consequent changes of induction being measured by the galvanometer. The tardiness of change of current in the transformer, due to its self-induction, was sufficiently reduced by using many cells and a considerable resistance. The results are shown in Curve V. for a single transformer. In this curve the abscissæ are the currents in the thin coil of the transformer, divided by 21 to reduce it to the same effect as it would have had if it had been in the thick coil. The ordinates are the inductions as measured by the kick on the galvanometer, but reduced to a scale to make them directly comparable with the volts when the transformer is used with an alternating current.

These results are not given in absolute units. The procedure to determine points on the curve was—first, pass the maximum current corresponding to the point C; next suddenly diminish the current by inserting suitable resistance in the thin-coil circuit, and observe the kick: the drop of ordinate from C to A corresponds to the kick, and the abscissa of A is the current after it has been reduced. Next, reverse the current and observe the kick. The kick corresponds to the further drop of ordinate from A to B. In this manner a series of points are determined on the curve. Curve VI. shows the relation between induction and magnetising current for the pair of transformers as deduced from the experiments with alternating currents set forth in Table I. The ordinates in this curve are the areas of the curve of potentials of Curve I., for the ordinates of this latter curve are the rates at which the induction is changing, whilst the abscissæ are the currents in the thick wire at corresponding times. The points marked 0 in Curve VII. give the remainder after deducting the magnetising current as estimated in Curve V. from the currents of Curve VI.—that is to say, Curve V. is corrected first for the small difference in maximum induction, then corresponding to any induction the current is taken from the curve, it is doubled as there is only one transformer, and the result is deduced from the corresponding current of Curve VI. The differences are the magnetising currents equivalent and opposite in effect to the local currents in the cores. If the local currents were equivalent to a current in a single secondary circuit, the points 0 of Curve VII. ought to have had the form of the full line of Curve VII. drawn through the points +, in which the abscissæ are proportional to the potential difference and the ordinates to the induction. Returning to Table I., we find that the fall of potential difference on open circuit in the whole combination is 0·8 volt, and that the loss of power in magnetising the cores and in local currents is 228·26 watts—that is, a loss for each transformer of 114·13 watts. The total loss of 228 watts may be divided into 126 watts accounted for by the hysteresis, and 102 watts due to local currents.

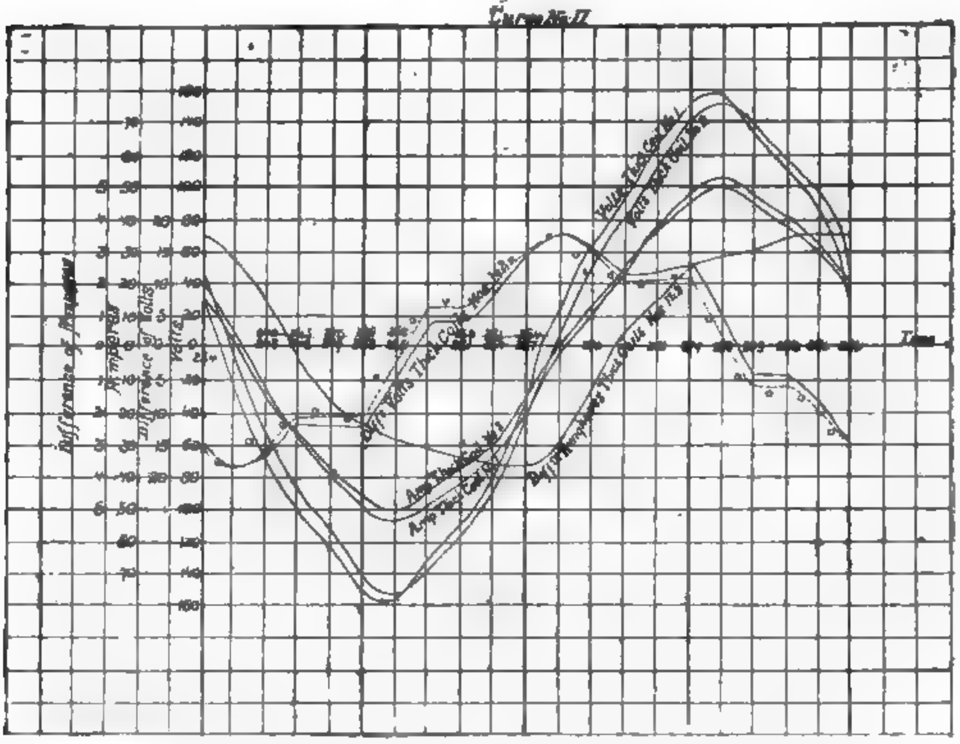
Referring now to Table III. and Curve III., the earlier columns explain themselves, but a word is necessary about the last six columns. The watts supplied to No. 1 are simply the products at each time of the volts at its terminals and the amperes passing through it, similarly to the watts given out by No. 2. We see, firstly, that the efficiency of the whole combination with this load is 93·73 per cent., and hence the efficiency of one transformer, if the losses in the two are equal, may be taken as 96·9 per cent. The fall of potential in the whole combination is 6·1 volts, but the fall with no load is 0·8 volt, hence the variation due to the load with constant potential on the thin coils of No. 1 is 5·3 volts, or, if the fall of potential in the two transformers were equal, which it is not, for a single transformer 2·65 volts. Assuming that the transformers are equal, the power lost in resistance would be expected to be the mean of mean current X, the difference of potential difference, or 215·5 watts. It is in fact 150 watts, as given by multiplying the square of currents by resistances. But the transformers are not exactly equal, and there is the waste magnetic field, both of which will have a small effect on the distribution of loss between the two classes of loss—viz., that by hysteresis and local currents, and that by resistance, but none upon the gross efficiency.

The other tables, II. and IV., are arranged in exactly the

Curve I.

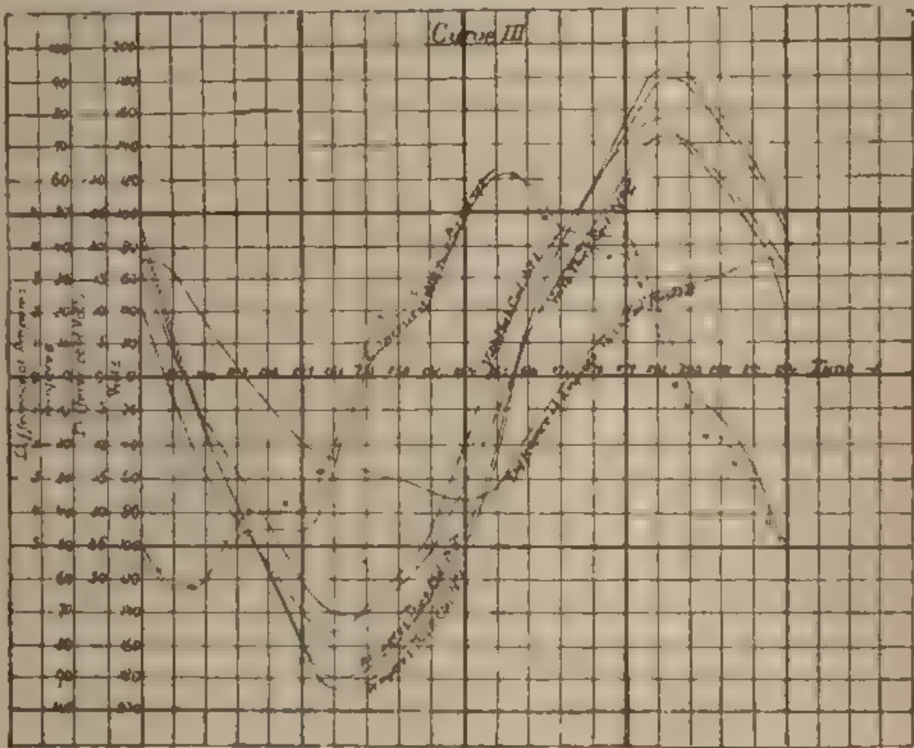


Curve No. II.

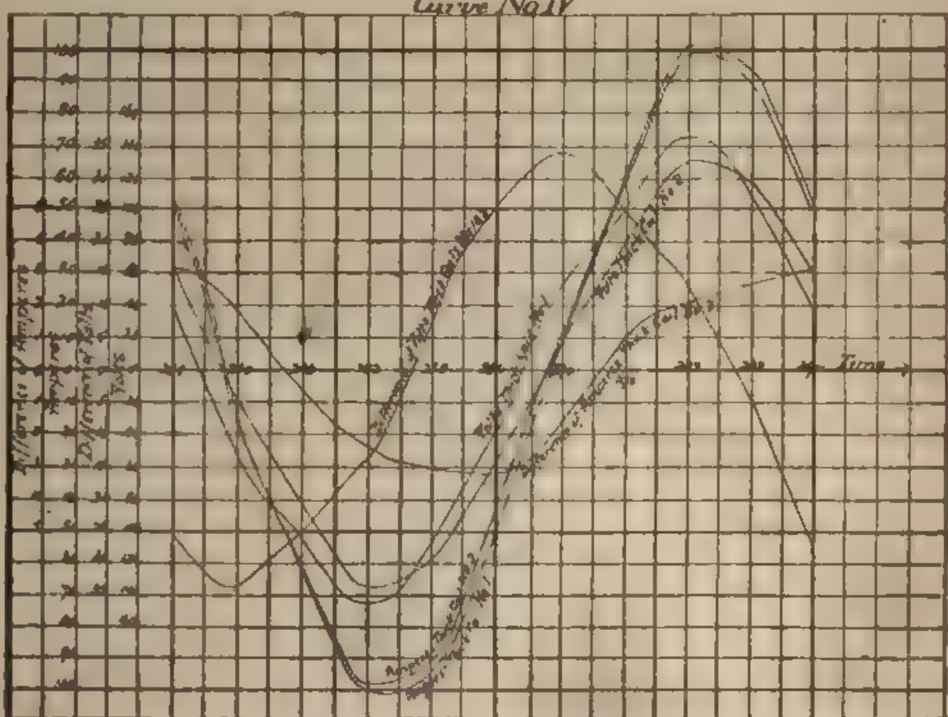


way as Table III., but the number of observations on Table IV. is insufficient to bring out all the peculiarities of the transformers.

It has already been stated, that if the loss of potential due to load in the two transformers be equal, it will amount to 2·65 per cent. The following experiment was tried to ascertain if this loss was equal. The transformers were coupled in series as before. The mean potential difference of the thick wire was measured by Thomson's multicellular and of the thin wires by Thomson's electrostatic voltmeter; the mean of a considerable number of experiments is given in the following table, the load being the same



Curve No IV



as in Table III., and the results being corrected to the same potential of the thin wire.

No.	Full load.		Open circuit.	
	Thomson multicellular.	Thomson electrostatic.	Thomson multicellular.	Thomson electrostatic.
1	2,380	99·8	2,380	99·0
2	2,380	94·2	2,380	96·2

This shows that of a total drop of 4·8 volts, 2·8 volts occurred in No. 1, and two in No. 2. There is no doubt of the fact that the drop is greater in No. 1 than in No. 2, which is connected with the waste field between the two coils. Of course these transformers are intended to work exactly as No. 2 is working, in which case the drop from no load to nearly full load, as shown by this experiment, is 2·0 volts. The way in which this waste field causes inequality of drop of potential in the two transformers, coupled as in my experiments, is very worthy of careful consideration. The waste field is proportional to the current in the transformers, or better, to the mean of the two currents in ampere turns. The E.M.F. due to this waste field will be proportional to rate of change of the current. If the current were expressed by a simply harmonic curve, the E.M.F. due to the waste field would also be a simple harmonic curve differing in phase by $\frac{\pi}{2}$. The curve of potentials is roughly in the same phase as the curve of current. Let A be the amplitude of potential difference of No. 2 transformer, B the amplitude of difference of potential difference in No. 2, or the potential difference of the thin wire divided by 24, $2b$ will be very nearly the amplitude of difference of potential difference between the thick wires of Nos. 1 and 2. The ratios of potentials in No. 1 and No. 2 will then be $\frac{\sqrt{a^2+4b^2}}{\sqrt{a^2+b^2}}$ and $\sqrt{\frac{a^2+b^2}{a}}$, or $1+\frac{3b^2}{2a^2}$ and $1+\frac{b^2}{2a^2}$, or the drop in the first from this cause is three times

as great as in the second transformer. We shall return to the waste field immediately. Putting aside harmonic curves, and returning to the facts as they are, the following Table V. gives, first, half the difference of potential difference taken from Table III.—that is, at each instant the drop of potential in No. 2; secondly, the volts of the thin wire of No. 2 reduced for number of convolutions—this is, of course, the mean of potential difference between 1 and 2; lastly, the squares of these volts. From this we see a mean square 100·8, showing the drop in No. 2 to be 2·6 volts out of a total drop of 6·1, and the remainder 3·5, the drop in No. 1. Diminishing these results by 0·4, the half of 0·8, the fall observed with no load, the actual losses from no load to nearly full load will be 2·2 and 3·1.

Turn now to the last column of Table III. This gives the difference of potential differences corrected for the loss of volts by

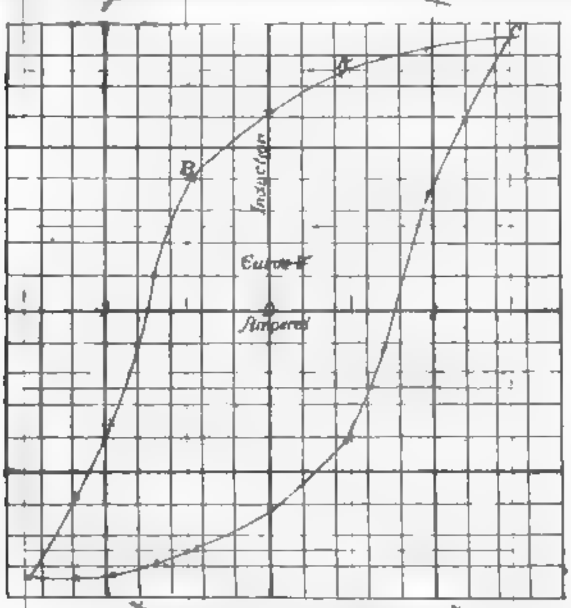
268½	271½	274½	277½	280½	283½	286½	289½	292½	—
30·7	24·2	19·2	18·5	13·9	1·7	−9·3	−12·7	−21·7	−28·1

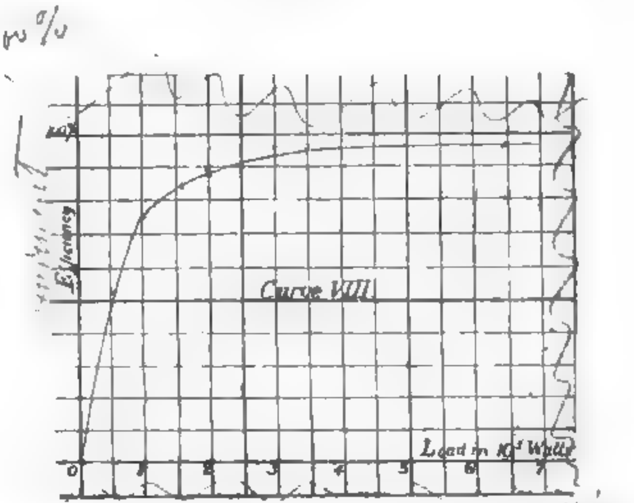
which happens to come to a scale which can be at once plotted. The points marked 0 are the points of the curve corresponding with the above rates. The agreement of the points with the curve is remarkably close. This exhibits very completely the effect of waste magnetic field in this transformer.

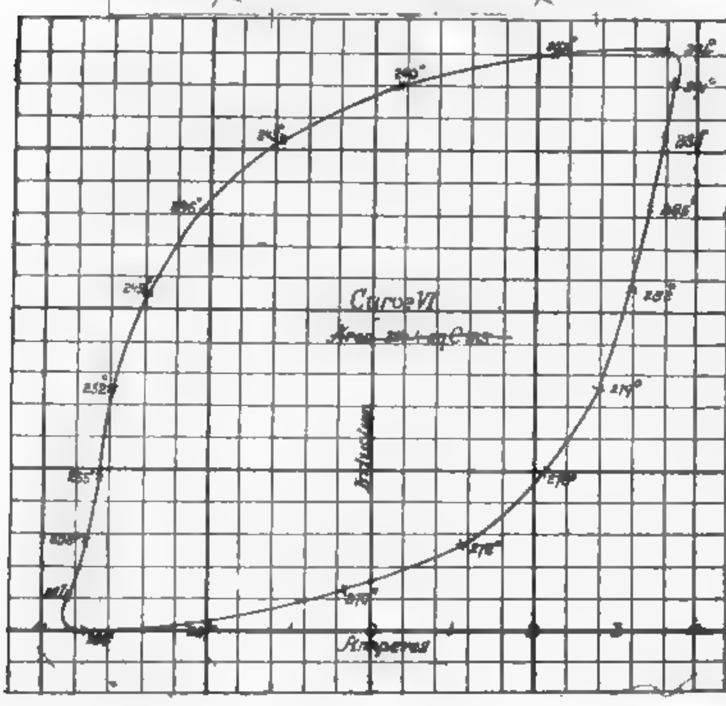
For half power as taken from Table II. the rates are as follows:

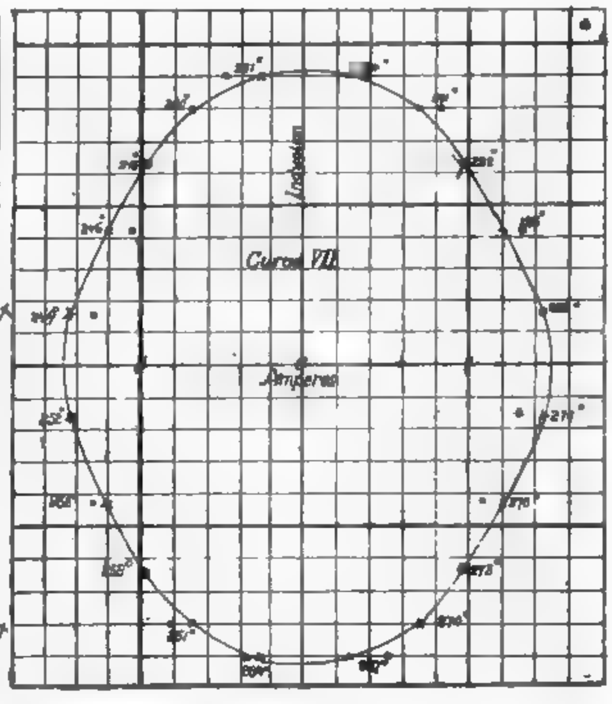
268½	271½	274½	277½	280½	283½	286½	289½	292½	295½
14·6	11·5	9·4	10·6	4·4	−4·6	−7·2	−7·5	−13·6	−17·6

and in the same way in Curve II. the dotted curve represents the difference of E.M.F. corrected for resistance, and the points correspond with the above rates.









resistance. It is shown on the dotted curve, III.; this curve presents one or two peculiar features.

TABLE V.

Half difference of potential difference.	Volts of high-potential coil divided by 24.	Squares of Volts.
15·6	−5·0	25·0
[redacted]	41·3	1706·0
11·3	74·3	[redacted]
[redacted]	102·6	10530·0
11·1	131·3	17240·0
5·5	147·1	21640·0
− 1·1	137·0	18770·0
− 3·1	119·3	14230·0
− 5·9	95·1	9040·0
−12·1	53·4	2850·0

Square root of mean square = 100·8.

It should be possible to infer the form of this curve from the curve of current. The rates at which the mean current is changing are as follows.

Curve VIII. gives the efficiencies in terms of the load. This curve is the hyperbola

$$x - \frac{(A + Bx + Cx^2)}{X}$$

Efficiency = 100.

Where A = 228, the loss by hysteresis;
B = ·005 and mainly depends upon the waste field;
C = ·0000035 and is mainly the loss by resistance;
X = Load in watts.

To sum up, I find that the efficiency of the transformer at full load would be 96·9 per cent., at half load 96 per cent., at quarter load 94·7 per cent. The magnetising current of the transformer amounts to 114 watts, or 1·75 per cent. The drop of potential from no load to full load is between 2 and 2·2 per cent.

In conclusion, I wish to express my thanks to Mr. Wilson, of King's College. This gentleman carried out the experiments under my direction, and made nearly all the numerical calculations, and drew most of the curves for me.

Dated this 31st day of May, 1892. (Signed) J. HOPKINSON.

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NOTICE.

With this issue of the Paper is given a Supplement containing Portraits, taken from photographs, of **Dr. J. Hopkinson, Dr. E. Hopkinson, Mr. William J. Hammer, Mr. Alfred R. Bennett, and Mr. Emile Garcke.**

Every reader should see that he gets this Supplement, and non-delivery with the Paper should be reported at the Publishing Office.

THE TRAMWAYS INSTITUTE.

Perhaps this issue will be looked upon by some readers as too much about tramways, but in this direction Englishmen need shaking up. Hitherto tramway work has been somewhat of a prosaic character—by that we intend to indicate the prevailing custom to ignore the immense possibilities of electricity for this work. But there are indications of a better time even in this horse-mule-steam beridden land. At the general meeting of the Tramways Institute, held last Tuesday, three of the papers were wholly devoted to electrical subjects, one was common to all kinds of traction, and the remaining one was about an oil engine. With the exception of the latter we give a full report of these papers, and trust that it may prove the forerunner of many future reports dealing with the application of electricity to tramways. Although the progress in this country has been slow, we can boast of the biggest practical application in the City and South London Railway, and the successful working of this line has led to the promotion of various lines to be worked electrically. Liverpool also is to have its overhead electric railway, but we desire to chronicle progress in tramways pure and simple. One great reason why more has not been done was given by the president of the institute, Mr. Carruthers Wain—that the required capital was not forthcoming. Tramway work has not been so financially successful as to easily induce capitalists to subscribe money for new departures, though the experience in America should indicate that improvement pays. Mr. Frank J. Sprague, in his inaugural address to the American Institute of Electrical Engineers, dealt with coming developments of electric railways, and, among other things, said: "Electric street railways are no longer experimental, nor is their success problematical. Their history for the past five years is that of an almost unequalled development. Almost within a decade has occurred the first working of a practical electrical railway. In a third of that period there have been put in operation or are under contract more than 450 roads, equipped with nearly 6,000 cars, over 10,000 motors, and with over 3,000 miles of track. There is made a daily mileage of not less than 700,000 miles, and over a billion passengers are carried annually. . . . Thirty thousand horses in a single year have been relieved from the slavery of street-car propulsion; stables are disappearing and streets becoming cleaner; luxurious cars are running on smooth, well-built, and rigid road-beds. Dividends have been increased, expenses reduced, investments enlarged, the unproductive have become productive, the impossible possible. Land values have been increased, habitable limits extended, houses erected, and time saved." That is what is said of electrical tramways in America. In England the president of the institute tells us that some 200 miles of tramways have been authorised by Parliament, and that, to obtain this authorisation, have been proved to be wanted, but have not been constructed because capital could not be obtained. He also heard that the Blackpool electric tramway was likely to come to an end, not because it was unsuc-

cessful, but because the wisdom of the local authorities was against granting a renewal of the lease. On the other hand, there is hope that the line at Leeds may be extended, that Bradford will take up the work, and within two or three months that the South Staffordshire lines will be opened. These are with overhead conductors, and, although not exactly on the same system as the Leeds line, are far more cheaply constructed than with underground conductors. To us one of the most potent factors compelling sooner or later the adoption of electricity, or some other suitable agent, is the relief of horses from tramway slavery. It is to the members of the Tramways Institute we must look for action. They know the difficulties they now have to contend with, and have the responsibility of procuring a dividend for the shareholders upon their shoulders. Once convince them that increased revenue will come from the adoption of the new method, they will aim at its introduction as their means allow; and when equipping new lines will endeavour to carry out the system that seems likely to be the most profitable.

CORRESPONDENCE.

"One man's word is no man's word.
Justice needs that both be heard."

TUESDAY NIGHT'S THUNDERSTORM.

SIR,—The storm of to-night has been a very severe one, and the lightning has been especially vivid. One flash was very noticeable in the neighbourhood of Leyton just before 9 o'clock. It was a vertical flash from clouds to earth, and its path was almost straight (of course it was of a zigzag form, but the main direction was straight). This left behind it a stream of golden sparks which gradually died out, resembling somewhat a rocket. This flash was noticed by several, and the stream of sparks was specially commented upon.

There were numerous other flashes, some representing chains, others tridents, others were semicircular and all manner of shapes. The colour, too, was very noticeable, some almost white, others amber, some violet.—Yours, etc.,

WILLIAM B. CLARKE.

2, Mortimer-villas, Wingfield road,
Walthamstow, 28th June, 1892.

[We ourselves noticed the flashing between the raindrops, during this thunderstorm, in a London street.—ED. *E. E.*]

OUR PORTRAITS.

Hopkinson, Dr. John, is the eldest son of Mr. Alderman Hopkinson, of Manchester, and was born in the year 1849. His mother is a daughter of the late John Dewhurst, of Skipton. His brother Alfred is Queen's Counsel. His education commenced at Lindow-grove School, and was afterwards carried on at Queenswood College, but he left there at the early age of 15½ to enter Owens College, Manchester, where he remained until he was 18, when he entered Trinity College, Cambridge. In the year 1870 he graduated as Doctor of Science in two branches in the University of London, taking as his subjects Pure and Applied Mathematics and Light, Sound and Heat, under the original regulations for that degree. In the following year he graduated at Cambridge as Senior Wrangler and First Smith's Prizeman. These two honours have not very often been obtained by the same man, as the Smith's prize examination is essentially a test of mathematical creative power, or capacity for original work; while the mathematical tripos has always been rather to test a man's capacity of assimilating, and reproducing with accuracy and rapidity, the work of others. By obtaining the first place in both examinations, Dr. Hopkinson therefore showed that both his receptive and creative mathematical powers were of a very high order, and this early promise has been amply fulfilled throughout his subsequent career. It is a fact not unworthy of notice in these days, when the fierceness of competition leads many ardent young students to commit the fatal mistake of neglecting physical exercise, that while at Cambridge Dr. Hopkinson was known as a good oarsman and runner, and that he won a footrace only three weeks before the commencement of his tripos. Early in the year 1872 Dr. Hopkinson accepted the appointment of engineer to Messrs. Chance Bros. and Company's lighthouse works, near Birmingham, at which town he lived until 1878, when he moved to London, and began practice as an engineer on his own account—without, however, giving up his connection with the firm, a connection which still continues, and which has resulted in many improvements in lighthouse work: notably the group flashing apparatus. After his removal to London he very soon became widely known as an expert in patent cases, a branch which still forms an important portion of his practice. In addition to acting as consulting engineer to the Metropolitan Electric Light Company and several other companies, Dr. Hopkinson has carried out a good deal of constructive work. He is now acting as engineer to the Manchester Corporation in lighting the town. From 1877 onwards he contributed a number of able papers to the Royal Society. During the years 1879 and 1880 Dr. Hopkinson read two papers of very exceptional importance on "Electric Lighting" before the Institution of Mechanical Engineers. In the first of these he described a number of experiments made with a Siemens dynamo to determine its efficiency under varying conditions, and mapped out the relations between E.M.F. and current by means of curves, since called "characteristic curves" by M. Marcel Deprez. In the second paper a number of somewhat similar experiments subsequently made by other observers on Siemens and Gramme dynamos, were mapped out in the same way, and the observations were thus made comparable with one another. It also contained descriptions of a method of measuring the brightness of the electric arc, and the determination of the ratio of the potential difference at the ends of the carbons to the current passing. Early in the year 1883 Dr. Hopkinson made some improvements in the Edison dynamo, which proved to be of exceptional importance as forming the basis of subsequent important improvements in dynamo machinery. In the same year he was appointed to deliver before the Institution of Civil Engineers one of a series of lectures on "The Practical Applications of Electricity." His lecture was entitled "Some Points in Electric Lighting," and in addition to a most masterly general exposition of the subject, he developed in it some very important points, such as the possibility of running two or more alternating machines in parallel, and the relations between the efficiency and the dimensions of a dynamo, and he also pointed out that the fact previously observed by Mr. Shoolbred in experimenting with a series-wound Gramme machine, that after a certain current strength had been obtained the E.M.F. began to diminish, could be explained by the approach to magnetic saturation of the iron of the machine. The theory of alternating dynamos was further developed in a paper on "The Theory of Alternating Currents," read before the Society of Telegraph Engineers in 1884. In 1885 and 1889, Dr. Hopkinson read two very important experimental papers before the Royal Society, "On the Magnetisation of Iron," and "On the Magnetic and other Physical Properties of Iron at a High Temperature." Early in 1880 he discovered peculiar properties of an alloy in nickel and iron. In 1886 he read a very important paper before the Royal Society, "On Dynamo-Electric Machinery." This paper contained an account of investigations carried out in conjunction with his brother, Dr. E. Hopkinson, with the object of obtaining an approximately complete construction of the characteristic curve of a dynamo of given form from the ordinary laws of magnetism and the known properties of iron,' and to compare the results with the actual characteristic of the machine. Another very important

paper, "On the Electrical Illumination of Lighthouses," was read before the Institution of Civil Engineers in 1886. Dr. Hopkinson was elected a Fellow of the Royal Society in 1878, and he is a member of the Senate of the London University. In 1890 the Royal Society awarded to him one of the Royal Medals, and during 1890 he was the president of the Institute of Electrical Engineers. He is member of council of the Mechanical Engineers, and is professor of electrical engineering in King's College, where he does not lecture, but closely superintends the laboratory.

Hopkinson, Edward, M.A., D.Sc., M.I.C.E. Born in 1859, son of Alderman Hopkinson, M.I.C.E., of Manchester. Educated at Owens College, Manchester, and obtained an exhibition in mathematics at Emmanuel College, Cambridge, in 1877, and subsequently a Foundation Scholarship. He graduated as tenth wrangler in the mathematical tripos of 1881, and was elected to a fellowship at Emmanuel College in 1883. In 1881 he took the degree of D.Sc. in the University of London in the branch of electricity and magnetism treated mathematically. In 1882 Dr. Hopkinson became assistant to the late Sir William Siemens, and continued with him until his death. During this time he carried out the experiments at Portrush in connection with the first electrical tramway in the United Kingdom. He received a silver medal from the Society of Arts for a paper on the Portrush tramway, read before the society. After the death of Sir William Siemens, Dr. Hopkinson designed and carried out, in 1885, the Bessbrook and Newry electrical tramway, which is worked entirely by water power, and still continues to be the only electrical tramway on which both goods and passengers are carried on a large scale. He read a paper before the Institute of Civil Engineers on the construction and working of this tramway, which was awarded a gold medal and Telford premium. In 1887 he became a partner in the firm of Messrs. Mather and Platt, of Salford, and undertook the charge of the electrical engineering department, of which he continues head. He is the inventor, in conjunction with Dr. John Hopkinson, of the Manchester dynamo, and of various improvements in connection with dynamo machines and the applications of electricity. He is the joint author, with Dr. John Hopkinson, of a paper on "Dynamo Electric Machinery," printed in the *Transactions* of the Royal Society. He designed the electrical plant for the City and South London Electric Railway, and the electrical part of the work was carried out under his direction.

Hammer, William J., at present a consulting and supervising engineer, is especially well known for his long and intimate connection with the rise of incandescent lighting in America. He was one of Mr. Edison's private assistants in the Menlo Park laboratory at the very beginning of the development of the incandescent lamp. In connection with Mr. E. H. Johnson he established the first station in the world for incandescent lighting as electrical engineer of the English Edison Company, and superintended the elaborate Edison display at the Crystal Palace Electrical Exhibition in 1882. During the next two years he was chief electrician and engineer of the German Edison Company, and introduced incandescent lighting into Berlin. For two years he served as chief inspector of central stations of the Edison Company, and represented that organisation at the Franklin Institute Exhibition in 1884, the Cincinnati Exhibition of 1888, and the Paris Exhibition of 1889. He constructed and operated the largest plant of electrical engineering work ever made for special effects at the Centennial Exposition of the Ohio Valley and Middle Atlantic States in 1888. He has acted in an expert capacity for the various Edison interests in connection with the Ponce de Leon plant and others, and conducted the most elaborate economy test upon the Harrisburg station which has ever been made in that country. Mr. Hammer conducted some remarkable experiments in sound transmission between New York and Philadelphia, employing both telephones and phonographs, which received great attention here and abroad, and on account of which he was presented to the French Academy of Sciences and the International Society of Electricians. He has made some highly interesting and original experiments in war ballooning, signaling, sound, and special applications of electricity, and owns a large number of patents for his own inventions. He was one of the three incorporators of the Sprague Electric Railway and Motor Company, and as manager of the Boston Edison Company established the first commercial station for transmission of power, installing at first 92 motors. He is well known in connection with the development of the phonograph. At present he is working as an engineer on his own account. Soon after the inauguration of the 1892 exhibition at the Crystal Palace, Mr. Hammer came over to England as representative of various American interests—among others, those of Mr. H. Ward Leonard, the Carpenter Heating Company, the Ries Electric Specialty Company, the Weston Electric Instrument Company, Ward Arc Lamp Company, Telemeter Company, Pilkington and White, and others. During his long and intimate career with electrical developments Mr. Hammer has taken a great part in disseminating information, and is always alert to fully investigate any improvement which may be brought to his notice. He is vice president of both the American Institute of Electrical Engineers and the New York Electrical Society, and prominently identified with all the American electrical organisations. His numerous friends, whether on this side or on the other, can fully rely upon his business instincts when trusting their business into his hands. If we permitted ourselves to discuss the merits of Mr. Hammer from a social point of view, we fear his numerous friends would impugn the possibility of getting sufficiently vigorous language to adequately express their high appreciation of his character.

Bennett, Alfred Rosling, M.I.E.E. Born in London March 14th, 1850. Educated principally at Belle Vue Academy, Greenwich. Mr. Bennett is best known to the electrical world at the present time as one of the ablest, if not the ablest, of telephone engineers. For years the study of telephony in all its details has engaged his attention, and in carrying out practical work he has been pre-eminently successful. Mr. Bennett, however, had the great advantage of coming into telephonic work with a mature and ripened experience in telegraphic work, for so long since as 1860 he went to India in the service of the Indian Telegraph Department, where he had a varied and very successful experience. On his return to England in 1873, he for a year or so was with the Highton Batteries Company, and afterwards with the Magneto Company. During the period to May, 1880, he was active in different directions, paying considerable attention to literary work, but in May, 1880, he joined the United Telephone Company, and from then to now has gradually won a foremost position in the industry. He is answerable for many improvements in telephonic apparatus, some of which were patented. In 1883 he joined the National Telephone Company as engineer for their Scotch and Irish districts. We cannot here enter into a critical consideration of papers read or improvements made in apparatus, but in both directions very valuable work has been done by Mr. Bennett. We might just refer, however, to the exceedingly interesting papers read at the Institution during the Edinburgh Exhibition, and more recently at the British Association. Subsequently severing his connection with the National, he became engineer to the Mutual, and strongly advocates the complete metallic circuit system, which under his directions has been admirably carried out at Manchester; and throwing in his lot with the New Telephone Company in London, he has been instrumental in assisting to rouse public action towards improving the telephonic facilities of the metropolis. We can only trust that these labours will lead to London taking the foremost place in telephony that its size and wealth predict.

Garcke, Emile, is the managing director of the Electric and General Investment Company, a very successful company which he and others formed in 1890 to facilitate the promotion and development of undertakings for electric lighting, traction, transmission of power, and other industrial uses of electricity. He became connected with the electrical industry in the beginning of 1883, when he joined the Brush Company. Since then he has been closely identified with the progress of that company, having been successively secretary, manager, and managing director. He has lately resigned the management of the

company, but he still occupies a seat at the board. At the last general meeting of the shareholders, the Duke of Marlborough, the chairman of the company, speaking of the City of London electric lighting undertaking, said: "I cannot impress upon you too strongly what an immense advantage it is to you to have obtained this valuable order, and in passing I cannot help saying that you owe that entirely to the services and persistent labour of your managing director. Although your board have given every attention that they could to your affairs, it would have been impossible for them to have negotiated this enterprise. For several years Mr. Garcke has been working at this thing, and he has succeeded in carrying it out, and I must say that I think it is largely owing to his successful labours in this matter that we were able to come forward and make such a favourable report to you, not simply with regard to the balance sheet, but with regard to the prospects of your company generally." But it is not only on behalf of the Brush Company that Mr. Garcke has done good and hard work. Our contemporary the *City Leader*, in one of its recent articles on "City Men at Home," stated that it is admitted even by Mr. Garcke's rivals in trade that while he has pushed forward the interests of the Brush Company, he has always kept in view the welfare of the industry. He was one of the first to take up the question of the amendment of the Electric Lighting Act of 1882. He organised, with Lord Thurlow, the first deputation to the Board of Trade on the subject, and afterwards acted as hon. secretary to the committee which, at the suggestion of Mr. Chamberlain, was constituted to draw up draft clauses. He is one of the vice-chairmen of the Electrical Section of the London Chamber of Commerce. He is also a director of the Chelsea Electricity Supply Company, of the County of London Electric Light Company, and of the Bath Electric Company. He is a Fellow of the Royal Statistical Society, member of the Institute of Electrical Engineers, of the Institute of Actuaries, and of other societies.

THE TRAMWAYS INSTITUTE OF GREAT BRITAIN AND IRELAND.

Between 70 and 80 members and visitors, among whom was a sprinkling of electrical engineers, assembled on Tuesday at a special general meeting of the Tramways Institute of Great Britain and Ireland, held at the Guildhall Tavern, E.C.

Tramway men had met to discuss their own particular business, and electrical engineers had gathered to once more lay before the former the subject of electricity as a motive power. Mr. W. Carruthers Wain, who presided, was unanimously re-elected president for the forthcoming 12 months, on the motion of Mr. A. P. SMITH, seconded by Mr. G. P. BRADFORD. Other formal business was then transacted, after which

Mr. ELLIOTT, the secretary, presented the annual report, from which it may be interesting to give the following abstract. It was therein pointed out that 34 companies were members of the institute, and that there were also 62 delegates and 150 associates. This showed an increase of five companies since the last report, of six delegates and 52 associates. On the other hand, two companies had ceased to belong to the institute (one owing to liquidation, and the other to legislation), whilst 12 associates had ceased to be such owing to promotion, resignation, and death. The council urged most strongly upon the members of all classes the paramount interest to increase, by the addition of other companies and associates, the power and influence of the institution, as there could be no doubt that one result of the general election would be legislation which, unless carefully supervised and properly dealt with, must have injurious effects upon tramways and the shareholders. The desire of the council had been to bring before the members the latest inventions in traction or improvements on existing methods, and any other inventions having for their object the benefit of tramway companies. In these directions they had been successful. With regard to the matters discussed at the three meetings held during the year, they included, amongst others, the rating of tramways, the traction of tramways by means of compressed air, oil, gas, and electricity, new brakes; and the amendment required to the Tramways Act of 1870. It was to be regretted that the Board of Trade had refused to give facilities for the promotion of the Bill prepared by the institute for the amendment of that Act. The Board had also declined to support, and refused to assist, a motion to be brought forward for an enquiry to be made into the working of the Tramways Act of 1870. They, however, hoped "that in the event of a Unionist Government being returned the matter might be considered favourably next year." The result of the policy of the Board of Trade in this direction was that tramway progress had been greatly retarded.

Mr. CARRUTHERS WAIN, in moving the adoption of the report and accounts, congratulated the members on the satisfactory condition of the institute. He quoted Mr. Preece's figures concerning the development of electric tramways since Siemens constructed the first electric tramway from Berlin to Lichterfeld 11 years ago. What a difference there was between England and the United States as regarded electric lines! Certain tramway companies, as the report had pointed out, had had to go into liquidation, and in the case of Blackpool the Town Council had actually refused to renew the lease to the present company, and was now advertising for tenders all over England. Even with this discouragement, they had endeavoured to make good progress, as, for instance, the line in Leeds, due to the enterprise of America, and at Bradford there was a short trial line due to a firm of electrical engineers. In South Staffordshire they were going to have an installation which he hoped would be opened in time for the next quarterly meeting. With regard to the different inventions the promoters would find, as they (the tramway companies) had found, that it was almost as difficult to secure capital to buy them as it was to purchase tramways. The local authorities should have the tramways and the companies should work the lines; but municipal authorities should, for various reasons, not operate the tramways. After giving some figures concerning the slow growth of tramways in the United Kingdom, he concluded by impressing upon the members that pressure should be brought to bear upon parliamentary candidates at the forthcoming election, so that a committee should be appointed to enquire into the working of the Tramways Act of 1870.

Mr. A. P. SMITH seconded the motion, which was carried.

The report of the committee on mutual assurance against accidents was then presented by this gentleman. The report recommended generally that a company should be formed to undertake the insurance of the tramway plant. In the discussion on this matter a difference of opinion was expressed as to whether, among other points, if such a company were formed, it could be made self-supporting, and as to the liability of one company running steam cars and another operating with horse cars. It was eventually proposed and carried that the meeting generally approved of the outlines of the plan, that the committee was authorised to take such further steps as might be desirable, and that the matter be reported upon at the next meeting.

Mr. F. ARNALL, A.M.I.C.E., assistant surveyor of Birmingham, then read the following paper on

PERMANENT WAY CONSTRUCTION, ESPECIALLY AS REGARDS WEAR AND TEAR AND DEPRECIATION.

When tramways were first laid in Birmingham, the question arose as to whether they should be laid and maintained by the Corporation, or whether this work should be left to the company working the line. It was thought that as it was the duty of the Corporation to maintain the roads, it would not be altogether right to delegate that duty to a company whose used a part of the road for their private business, and whose primary object was not the care of the road, but the making of a profit in the using of a part of it. It was recognised, even in that early day of tramway enterprise, that from various causes the object for which the company had been called into existence might become a very difficult one to attain, and as the interests of the company and of the public using the road were not

identical, it was likely that there would be a tendency for the company to neglect the maintenance of the roadway. It was therefore decided that the tramways should be laid by the Corporation, and maintained by them on terms to be agreed upon with the several companies concerned.

The first tramways were laid in Birmingham in 1872, and in 1875, the lines forming a continuous route, about 4½ miles long, from one side of the town to the other. It was nearly all double line, and laid to a 4ft. 8½in. gauge. In construction the Larsen system was adopted—an iron rail laid on a continuous wooden sleeper, as shown in section in Fig. 1. It was found that although the rail was fastened to a continuous wooden sleeper its bearing upon it was evidently very discontinuous: the wood warped and shrunk in a way that the iron rail could not follow, and however firmly it was fastened down it soon worked loose. As this system of construction in and about Birmingham is, however, now a thing of the past, it is hardly worth while now to go into detail as to the merits or defects it possessed. A part of it was taken up in 1887 for the construction of the Hockley cable tramway, and the remainder in 1889 for the construction of the Bournbrook electric line.

Steam traction was introduced into Birmingham in 1882, and it has since received a very extensive development; its growth was rapid, but soon checked. Between 1882 and 1887 the three companies using steam on the Birmingham tramways acquired altogether about 120 locomotives,

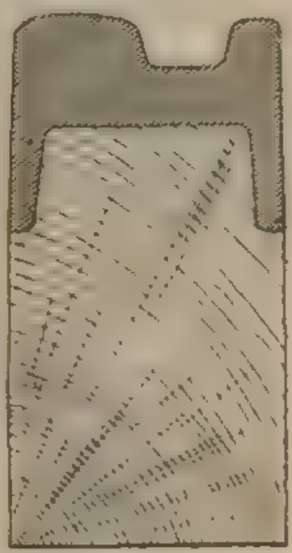


Fig. 1.

and I believe the various companies have always done their best to keep as many as they possibly could at work on the roads. This paper deals more particularly with the effect of this steam traffic upon the tramways, rather than with the tramways themselves, and the Birmingham results are the more important because the traffic upon the lines is so exceptionally heavy. In some streets there are four lines of routes overlapping each other, and in other streets as many as five lines, each route having quite a full complement of cars running over it. The result is that we have as much wear and tear on these tramways in five years, or in four years, as the case may be, as we get on a single route in 20 years. This is, of course, apart from the effects of ordinary traffic, which I believe to be very small indeed.

Knowing, then, the actual amount of wear in five years where four routes run over the lines, we have a good guide as to the amount of wear to expect on a line over which the traffic from only one route passes will sustain in 20 years. Many things may conspire to increase the effect on the single route in the long period of 20 years, such as corrosion, the long-continued effect of ordinary traffic, the natural growth of the district and consequently more frequent service, and so on, but I know of nothing that can possibly diminish the effect, except that the engines, etc., taken over the lines be reduced in weight or number, which can hardly be expected.

This point of view does not seem to me to have yet received at the hands of the institute the attention which it deserves, especially bearing in mind its important bearing upon the question of depreciation, or of prolonged maintenance, as apart from casual everyday repairs. Generally speaking, every case of repairs is a renewal of some part or another; it may be the replacing of a broken point, or only the renewal of the bedding under the adjacent paving stones, or of the grouting between them. Those engaged in the maintenance of steam tramways generally have a pretty good notion as to what everyday repairs means, but the almost imperceptible wear and tear to the rails themselves, which is always going on but which generally takes a long time to make itself visible, when not overlooked altogether, is generally only provided for in an indefinite sort of way by a depreciation fund. The traffic on some of the steam routes in Birmingham has already produced some results which may serve as data to assist in determining what this depreciation fund should be in similar circumstances, and, properly interpreted, may even be of service in circumstances which are not similar.

The first tramway laid for steam in Birmingham was the Birmingham and Aston route in 1882—a length of about one mile of double line inside the borough, laid by the Corporation, and a further length of about three miles or thereabouts in the district of the Aston Local Board, laid by the Aston Tramway Company. The gauge was 3ft. 6in., the rail used being that known as Barker's: a steel rail, 42lb. per yard, keyed to a cast-iron sleeper, as shown in section in Fig. 2. The sleepers were cast in lengths of 2ft. 11in. each, and laid with a gap of only 1in. between

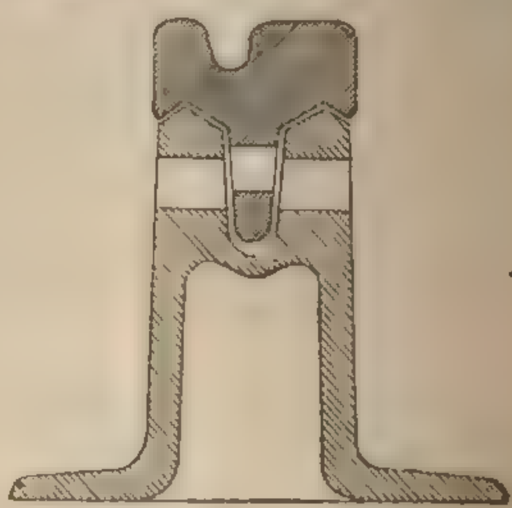


Fig. 2.

them, so that they were practically continuous. They were moulded by machinery, and were as nearly true on the upper surfaces as castings not machined over can be, and though they formed a nearly continuous line, it soon became evident that they did not form a continuous bearing for the rail. In a very short time after the line was opened, the rails began to work loose at the joints, which were always in centre of sleepers, and in spite of all tightening up and replacement of keys, this defect gradually spread along until the rail was loose from one end to the other; and the next result was, of course, the loosening and sinking of the paving stones along side. A length of 200 or 300 yards in Corporation street was left unpaved, and here the keys could be readily got at for tightening up, etc., but it was found that the rail did not become loose because the keys were not tightly driven in, but because they were cut away by the harder rail. A trial of some steel keys was made, but it was found that they caused the edge of the hole in the rail itself to cut away, so they had to be abandoned.

It was found that the steam traffic was really subjecting the rail to a process of "cold rolling," which lengthened out the upper surface, while the lower parts of the rail remained unaltered. As a result the rail tended to assume an arch or bow form, and when all the keys in a 30 length of rail had been knocked out, the loose rail rose in the centre 6in. or 9in. It, furthermore, was no longer straight on plan, but curved, the tread or bearing surface of the rail being on the outside of the curve. The effect was that when keyed

down the rail was always in a state of strain, and the least looseness in the keys caused it to rise above its bed, and at the same time the horizontal curvature caused it to move sideways, so that when a car passed over it the lower parts of the rail did not fall directly in their proper places on top of the sleeper, and dust and grit from the road surface formed a most efficient grinding material which was constantly being renewed. Thus, the top of the sleeper wore away as fast, practically, as the top of the rail, and it, moreover, wore out of shape, and the notion that we should be able to replace the rails when worn out without having to disturb the sleepers, had to be definitely abandoned. This process went on until the flange of the wheel reached and run on the bottom of the groove, and then destruction went on more rapidly still, until towards the end of 1886, when the lines had been in use four years, some of the rails began to split along the groove and had to be taken out, thus terminating their career.

Four years seems a short life for a tram rail, but the conditions must be taken into consideration. The rail was in a macadam road, and the traffic over it, amounting to perhaps 30,000 steam cars in 1883, had rapidly increased until the fourth year, when it had to carry the traffic from five different routes, amounting to 120,000 cars in that year. The total in four years amounted to about 280,000 cars, roughly equivalent to somewhere about an average of a five-minute service during the period.

In lower parts of the tramway, where the road was paved all across, and where some of the traffic had been diverted

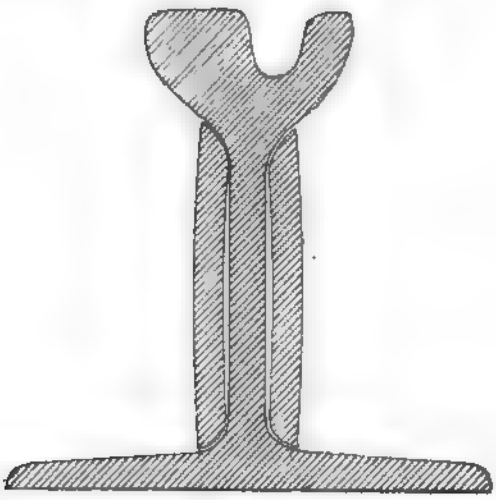


FIG. 3.

down other streets, the wear and tear was not so great—nevertheless, it was found necessary to take out and replace all the rails before the end of 1889, after the passage over them of about 380,000 steam cars in seven years. Outside the borough boundary the tramway company contrived to carry on for a few months longer, but took out their rails in the following year, after having been in service about $7\frac{1}{2}$ years and carrying the traffic of rather more than 400,000 cars.

Our experience thus shows that, apart from all questions of ordinary everyday repairs to paving, points, etc., the Barker rail will be worn out and done with, and must be replaced, after the passage over it of about 400,000 steam cars. If the new rails have to be put in in the nighttime and without disturbing the traffic, it may be taken that a mile of single line will cost about £2,000 in relaying it with girder rails, which is equivalent to about $1\frac{1}{4}$d. per car mile as a sinking fund to provide for the replacing of the rails alone.

The results I have indicated were, of course, not arrived at until after the Barker rails had been laid down for several years, but before even they were opened for traffic opportunity had been taken to examine the system and to gain lessons from its use elsewhere. The result was that when, in 1883, the Corporation were called upon to construct tramways for what is now called the Birmingham Central Tramways Company, the conclusion had been arrived at that the system was not suitable for steam traction. Considering the extensive system of tramways that the Central Company proceeded to construct, or have constructed, and the nature of the agreements already entered into between them and the Corporation, it is not too much to say that this decision of the Corporation has proved to be one of the utmost importance to the company.

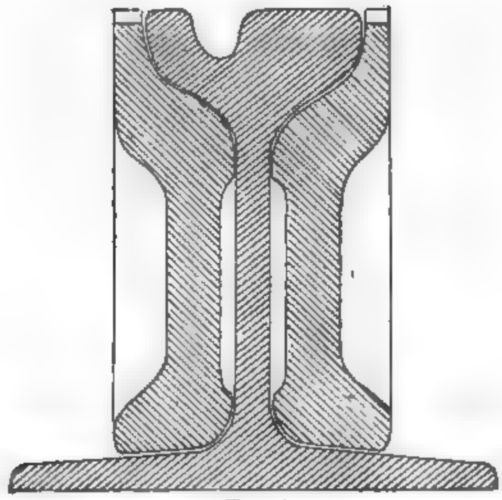


FIG. 4.

The system decided upon for the new tramways was the Gowan, or girder, rail, 7in. deep, to suit 6in. paving, 7in. wide on bottom, and weighing 98lb. per yard, the section being as shown in Fig. 3. The tenders of the Barrow Hæmatite Company were accepted for the supply of rails and fishplates, and, in fact, all the rails of this section hitherto laid by the Corporation have been supplied by the Barrow Company.

The joints were made of two 16in. fishplates, with four bolts, and were generally found to stand very well on a single route of tramway for the first two or three years, equivalent to the passage of, perhaps, 60,000 to 70,000 cars over them. After this they began to work loose, and the remedies resorted to—viz., tightening up the bolts and often replacing them, repacking the rail, etc.—are found to be only a temporary cure. For some time it was thought that the working loose was due to the nuts slacking back, or to the bolts stretching, and various varieties of locking nuts were tried, but with no beneficial results. The bolts may certainly have stretched a little, but the nuts certainly did not slack back or work loose, and it appears that the failure at the joints was due to several causes, which may produce different results under different circumstances.

It is not easy to imagine how a line of rails, properly fished together, and supported continuously on a solid bed of concrete, can work loose at the joints, but it is very certain that they do. The chief reason is to be found in

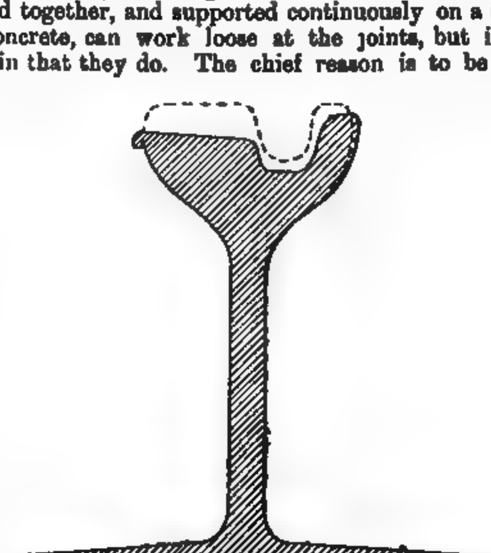


FIG. 5.

what I believe to be the fact, that on a steam route the rail generally is not continuously and equally supported, and, furthermore, it never can be for long together. The rail bears more solidly in some places than it does in others, bridging over the hollow places, and there is consequently

a minute deflection as the load passes over the places that are least firmly supported. When the joint happens to be over one of these slack places in the concrete the deflection will be greater. In the section of rail under discussion, deflection can readily take place, the head of the rail sinking between the tops of the fishplates, wedging them open. To be effective in resisting a tendency of this sort, each fishplate should act like an arch, the bolts passing through the

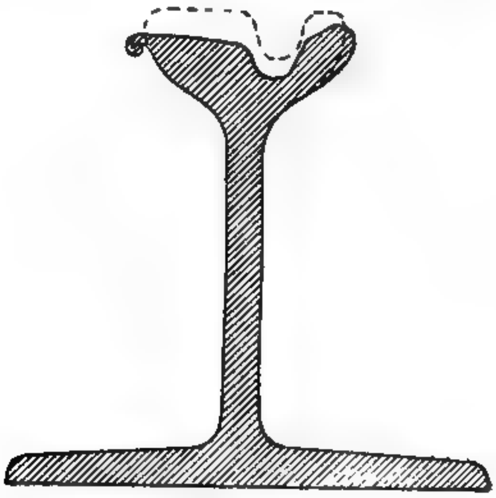


Fig. 6.

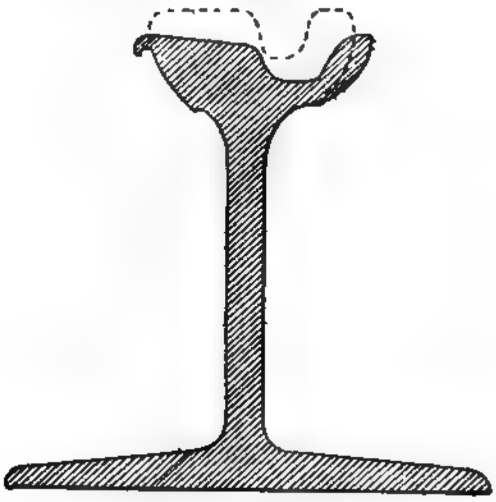


Fig. 7.

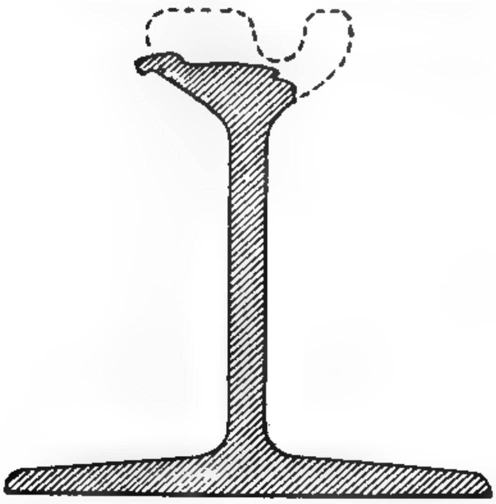


Fig. 8.

crown, the abutments being at top and bottom of the plate. In the Birmingham section, however, though we have a fairly good abutment at the bottom, there is a very bad one at the top, and sliding can very readily take place there, and does. The narrow edge of the plate is not a good surface for withstanding an action of this sort: it is too narrow; this is very plainly seen when a loose plate is an off, the top and bottom edges being often ground quite bright and smooth, and, generally, a more or less ledge is worn in them by the extreme ends of the rails

Many attempts have been made to deal with this w ness at the joints, with but imperfect success. In the route constructed by the Corporation the length of plates has been increased from 16in. to 24in., and number of bolts from four to six, but the traffic on this is comparatively slight, and as yet the soundness of

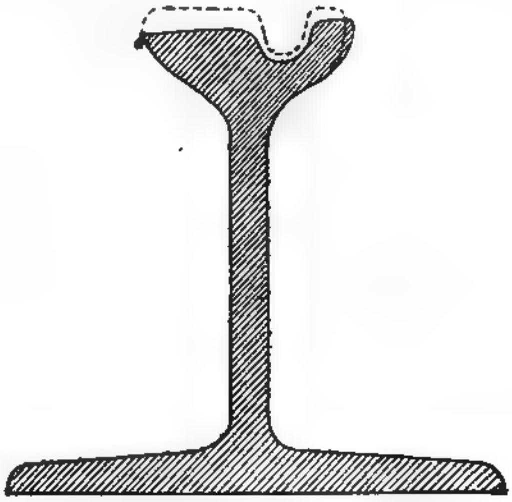


Fig. 9.

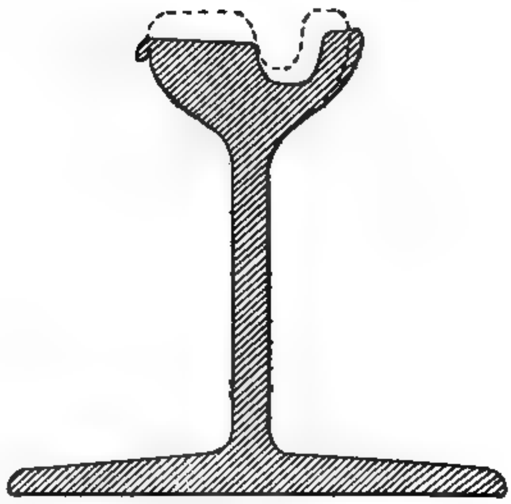


Fig. 10.

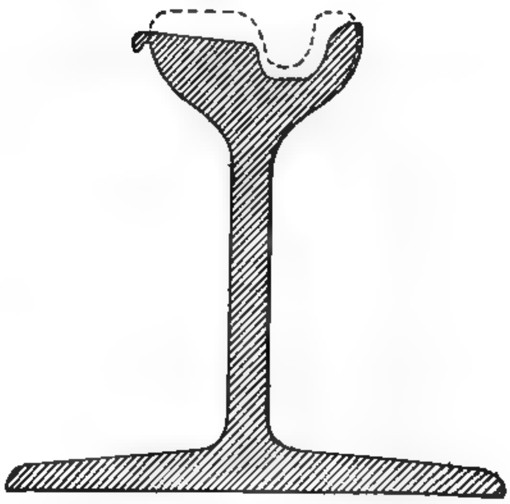


Fig. 11.

joints upon it is no criterion of what we might expect steam route with heavy traffic. A large number of Man sole-plates have been used; at first the plates were long, with four clips on each side, but these not bei all respects satisfactory, the length was increased to These long plates were practically no better than the ones, if so good. More close attention being paid movements of a loose joint under the traffic, it was

that the defect was rather with the clips, so I suggested that the two centre clips should be brought close together, and coalesced into one, the two bolts being retained. This form of clip turned out to be a great improvement on the old form, and I believe the plate is now as good as a sole-plate can be expected to be. It should be remarked that in our work these plates have been under one disadvantage, inasmuch as with the exception of one route, and that of light traffic, they have been put under joints that were already faulty, and mending a bad joint is not such easy work as delaying the failure of a good one.

To find what the effect of increasing the bearing area at top and bottom of the fishplates would be, a number of C.I. plates, 16in. long, and of the section shown in Fig. 4, were prepared. They fit the rail closely top and bottom, and the top is brought up to the street surface, and finished with a corrugated surface, and it will be seen that in screwing up the bolts there can be no tendency to make them ride up on their abutting surfaces. A trial length of line was selected, and a number of these plates put in in the autumn of 1890 in a street of very heavy traffic, and their behaviour is being compared with joints of other forms made at the same time in the same street, and under precisely the same conditions. They are still standing very well; where these plates are used without sole plates the joint seems about equally good as where ordinary fish-plates and sole plates are used, and where it has been used combined with a sole plate, the joint is better than any that has yet been tried in Birmingham. As the plates have been in a year and eight months only, it seems too soon to speak very positively of their merits; nevertheless, it is worth remarking that in that time they have had more than 250,000 steam cars over them, or the equivalent of a 10 minutes' service for about 12 years.

To refer again to the "cold rolling" process which has been already mentioned, I am persuaded that this action is one reason why we have so much trouble with the joints; its whole tendency is to lift the rail off its bed, allow dirt, etc., to get underneath in irregular patches, and thereby destroy the continuity of the bearing. The dipping at the joints, which is such a marked feature in a well worn steam tramway, is not so much a lowering at the joints as a lifting of the intermediate parts of the rail; and it is found that whenever a rail gets this hog-backed appearance, the trouble with the paving, which at first was only experienced at the joints, is now found pretty general all along the rail. It is furthermore to be remarked that the curving up in the centre is very much more with the same amount of traffic on a 6in. rail than it is on a 7in rail, and so much is this so that I venture to advance the opinion that nothing less than a 7in. rail is fit for use on a steam tramway of even moderately heavy traffic.

I have here, Figs. 5 to 11, actual sections of some rails that have been taken out of the Birmingham tramways, showing the effects of wear upon them.

No. 5:	Straight line, effect of	550,000	cars.
No. 6:	Flat curve	570,000	,,
No. 7:	Sharpe curve	570,000	,,
No. 8:	Straight line	560,000	,,

This example shows effect of expansion in wood paving, when allowed to become excessive.

Nos. 9, 10, 11: Straight line, effect of 670,000 cars.

All these sections show more or less the effect of tilting over of the rail, which is always to be found on a steam tramway, has upon the wear and tear of the rails the tread is not worn evenly down, but more rapidly towards the groove, leaving the flange standing up as a more dangerous obstacle to the ordinary traffic. From them some idea may be obtained of the great advantage which a rail with a central groove would have over one of the ordinary section.

These sections show that on a straight road a girder rail will be worn out, and require replacing after the passage over it of less than three-quarters of a million of steam cars. Many things may cause the number to be less, but nothing, except reduction in the weight, can cause the number to be greater. Taking the cost of relaying at £2,000 a mile, it works out that over and above the cost of everyday repairs, and maintenance of paving, etc., a damage to the extent of certainly over ·5 of a penny per mile is accumulating on the rails, and may some day want paying off all at once. How this liability is to be provided for is for the company to determine, but it seems to form a very definite factor in any depreciation fund that may require to be set aside to provide for future requirements.

Mr. COX, in the discussion, said the difficulty was at the joints. He had tried Marshall's sole plates, and was now trying Whytehead's joint-chair and fishplate. In the course of his experience he had found that single lines on tramways worked by steam wore as long as the double lines. Steam engines and cars passing all in one direction tended to break down the joints very much indeed; but on a single line that was counterbalanced by the traffic going in each direction. On the lines he was connected with, the fishplates wore in the same manner as Mr. Arnall had explained. They were 16in. long and ½in. thick at first, but better results had been obtained with longer plates ¾in. in thickness.

Mr. WROUGHTON was of opinion that the Barker rail gave "more trouble than enough." In 1886 his company had laid a short length of line with transverse sleepers where the road surface was very hard, and when General Hutchinson made an inspection recently, he was surprised to learn that not a single joint had been touched or anything spent on the paving. Cross sleepers were no doubt the best system.

Mr. A. DICKENSON, of Darlington, congratulated the author of the paper, and suggested that one of the methods by which the difficulty of joints might be overcome would be by reducing the number of the joints, and for that purpose electric welding or some other process could be used.

Mr. J. WAUGH, of Bradford, believed in the use of the Barker rails, which he had found to stand exceedingly well.

Mr. BRADFORD was strongly of opinion that transverse sleepers were the best. There was less oscillation when the foundation was firmer, and it was the oscillation which caused the joints to break; he was thoroughly convinced that cross sleepers were the best, and they ought to be used.

In the course of his reply, Mr. ARNALL stated that he did not think that the Whytehead joint-chair and fishplate would remedy the evil of the joints. People had made a diligent search for something to cure the evil of the joint, but up to the present they had not found it. The trouble did not so much arise from the inherent weakness of the joints, but from that process of "cold rolling" on the top of the rail. He agreed with what Mr. Cox had said regarding the cost or wear of the single and double lines. He had tried to discover the difference between the two, but could not do so. With reference to electric welding, he did not agree with Mr. Dickenson on that point, as such a process would increase the trouble through "cold rolling," to which he attached great importance. The cross sleepers would diminish noise, but, in reply to a question put by the president, he was unable to state what was the best system of laying tramways.

Mr. SHARP next read a paper on "The Further Development of the Connelly Motor in England and America."

The following paper was presented by Mr. G. ANNESLEY GRINDLE, C.E., on

ELECTRIC TRACTION: THE CITY AND SOUTH LONDON ELECTRIC RAILWAY.

The use of electrical energy to actuate motors for producing mechanical motion followed closely on the introduction of electromagnets. The first who seriously applied it to traction purposes appears to have been a Scotchman named Davidson, who during the years 1837 to 1839 constructed and worked a so-called locomotive capable of carrying two persons. The source of power was a primary battery, and, as may be imagined, the motor, or rather motors, were of a very crude description. But the idea was more than a mere toy, as the car measured 16ft. by 6ft., and the total weight some five tons, while a speed of four miles an hour is said to have been attained. From this time on there were many and varied attempts to solve the problem, but the want of a reliable and reasonable source whence to obtain the necessary current militated greatly against any good results, and we may therefore

pass over the period that elapsed, noting the invention of the Pacinotti machine in 1861, and the subsequent Gramme machine 10 years later, till the Vienna Exhibition of 1873, when the first practical and serious demonstration of electricity as a motive power was exhibited a Gramme dynamo, driven by a steam engine, transmitting the current to a similar Gramme machine at a distance of nearly half a mile, and from which power was taken to work a pump. Subsequent to this the application of electricity as a producer of motive power progressed but slowly till the summer of 1879, when a small experimental railway was laid down at an exhibition in Germany. The successful result of this small line already foreshadowed what could be done in this direction, and in 1881 an electrical line was permanently laid down for passenger traffic in Berlin, and continues in operation at the present date. In both the latter instances the electric current was gathered from the conductor as the car advanced, but at the close of 1881 the rapid development of storage batteries or accumulators gave fresh impetus to traction work, especially self-contained cars, and many and varied experiments and demonstrations have followed which are of sufficiently recent date to call for no special reference. The bulk, however, of these schemes and experiments has dealt only with light work, such as running of tramcars, and very little until quite recently has been done in what may be termed heavy work—that is to say, running of heavy trains and at considerable speeds. The first step in this direction was the Portrush, Bushmills, and Giant's Causeway tramway in the North of Ireland, which was opened in 1883.

This line when originally opened was some 6½ miles in length, and has since been extended an additional two miles. The line runs along the roadside with many very severe curves and gradients, and has a 3ft. gauge. The current is generated by water power, and conveyed to the motor by a rail erected at a slight elevation along one side of the track. The equipment consists of motor-cars, but the loads carried are not of very great weight. Steam power traction is also employed in the working of the line, which makes it somewhat difficult to arrive at the actual result and cost of the electrical working.

Following in this came the Bessbrook and Newry tramway, which may be regarded as the first serious attempt to deal with heavy goods, mineral, and passenger traffic. This line was opened for traffic in October, 1885, and, in addition to passenger traffic, has to deal with a heavy goods traffic. The line is a little over three miles in length, running from the Great Northern terminus at Newry to Bessbrook, and is built on private property. The gauge is 3ft., while the gradients average 1 in 80, with a maximum of 1 in 50. The line has practically a steady rise in one direction against which the motor has to draw a load of 18 tons, plus weight of car and passengers, at a speed of six miles an hour, or a load of 12 tons at nine miles an hour. The power for working the generating dynamo is obtained from turbines at a spot about midway along the line, and the current is conveyed to the motors through a steel conductor laid midway between the main rails. Two motor-cars, carried on 4ft. six-wheel based bogies, form the locomotive equipment, each car carrying 34 passengers, and weighing 8½ tons without passengers and equipped with an Edison-Hopkinson dynamo-motor of a normal output of 20 h.p., but which power in practice is often exceeded. The electric generating plant consists of two Edison-Hopkinson dynamos, capable of developing about 25 h.p. each. Only one is used at a time, and is found to be amply sufficient for the work required. The designing of the plant and equipment of the line was carried out by Messrs. Mather and Platt, of Manchester, to the plans and under the superintendence of Dr. Edward Hopkinson.

The conditions under which this line was constructed were fairly onerous. An outline of them was published in the *Proceedings* of the Institution of Civil Engineers, from which I make the following extract: "The company agreed to place the line entirely at the disposal of the author for a period of time, and to purchase the electrical plant at a fixed sum when the above conditions had been complied with, and it had been shown that the cost of working, as evidenced by six months' trial, did not exceed the cost of steam traction on a similar line. The work was commenced in November, 1884, and the line opened for traffic in October, 1885, and was formally taken over by the company, as having fulfilled the conditions of the contract, in the following April." Since that time it has been in regular daily operation. Considerable credit is due to the constructors for the way in which the matter was faced, the risks incurred, and the initiative made in this heavy class of work.

Following on this comes the subject of the present paper, and a short history here may not be out of place. In 1884 an application was made to Parliament for powers to construct an underground line from the City to the Elephant and Castle and granted. The want of such an undertaking had long been felt, and various schemes had been suggested to afford facilities for communication between the City of London and the densely populated districts on the south side of the river, and relieve the congested traffic over London Bridge, which, in 1886, when the railway was commenced, was estimated at 7,000,000 vehicles and 56,000,000 foot passengers per annum. The course taken for the line was from a terminal station adjoining the Monument, under the Thames, a few yards above London Bridge, and beneath the Borough, Blackman-street, and Newington causeway to the Elephant and Castle, following, as nearly as possible, the line of roadway, and so avoiding the cost of land purchase and compensation. The work of construction was commenced in 1886, and so gratifying were the results of the operations on this first section, involving as it did the difficulties of tunnelling under the Thames, that the directors applied to Parliament in 1887 for further powers authorising them to extend the line to Stockwell—making in all a distance of some 3¼ miles. The route for this extension was from the Elephant and Castle along the Kennington and Clapham roads, with stations at Kennington, Kennington-oval, and Stockwell. The work of the extension proceeded concurrently with the completion of the original section, and for obvious reasons the opening of the first portion was delayed until the completion of the scheme in its entirety from the City to Stockwell. Since the opening of the line to Stockwell, further powers have been sought and obtained for an extension to Clapham Common. This extension, however, has not yet been carried out, but will doubtless shortly be commenced, and cannot but prove a valuable addition to the undertaking, Stockwell being at present, at any rate, a poor centre for a terminal station. The system of tunnelling is somewhat novel, and introduced into this country by Mr. J. H. Greathead, M.I.C.E., to whom the design of the line is due, and under whose able superintendence the construction works were so successfully carried out. Entirely separate tunnels are employed for the up and down lines, so avoiding all possibility of collision between trains approaching each other in opposite directions. The material used in the construction of the tunnels is cast iron, built up in consecutive rings, each ring being composed of several segments, with a key piece. The tunnels are driven by a shield, which in form may be described as like a tube some 10ft. or 12ft. long, with a bulkhead, the internal diameter of the tube being slightly larger than the external diameter of the iron tunnel. A short length of soil is excavated in front of the shield, which is then driven ahead by means of hydraulic power, and the segmental ring is built up within the shield tube in the resultant gap caused by the forward movement between the bulkhead and the last built ring of the tunnel. The diameter of each tunnel is about 10ft. The stations are of brick and usual construction of arch and invert, and have a diameter of 22ft. The tunnels run, as a rule, side by side, excepting under the Thames, where one line is directly above the other. The depth of the tunnels below the surface of the roadway varies from 50ft. to 70ft., and is consequently below all sewers, gas-pipes, water-pipes, and subways, and causing no disturbance to the surface of the roadway. At such a depth the question of ventilation would appear to be a serious one, but as a matter of fact the tunnels are self-ventilating, and no special arrangement or machinery whatever is employed to effect what is generally acknowledged to be a very satisfactory

state of the air in the tunnel. This is due chiefly to the employment of separate tunnels for up and down traffic; the trains fit the tunnels almost like pistons, with the result that every train is continually changing the air, pushing, so to speak, a column of air to the station ahead, whence it escapes by means of the lift shafts, and sucking air from the shafts of the station last passed. Of course, at such a depth steam locomotion would be out of the question, and originally it was proposed to work the line by means of cable haulage, and, in fact, contracts for such means of running were actually entered into. In the interval, however, that elapsed between the first conception of the undertaking and the time when its accomplishment was in the near future the application of electricity to traction purposes had been advancing by leaps and bounds, and with the success attained on the Newry and Bessbrook line (on which the loads dealt with, as mentioned before, were but little, if any, less than those it was proposed to run on to South London line), Messrs. Mather and Platt were induced to approach the directors of the line with a view to obtaining their consideration as to the advisability of employing electricity as their motive power in lieu of cable, and to submit a complete scheme for the purpose, together with proposals for the working. The matter was the subject of long and careful deliberation by the board of the company, and was warmly taken up by the chairman, Mr. Charles Grey Mott, to whose untiring energy and deep interest in the matter a great part of the success of the undertaking is due. The submitted scheme was eventually accepted in its entirety, and a contract entered into in the early part of 1889 for the equipment of the line in accordance with the same. In addition to the actual equipment of the line, an offer was also made to work the line for a period of 12 months, or at the option of the company to guarantee the cost of haulage according to a sliding scale, dependent upon the train mileage run per annum, commencing at 3·5 pence per train mile for the full possible mileage of 384,800 miles per half year. The trains under the guarantee to consist of . locomotive, 10 tons; three coaches of 4·25 tons each, and 100 passengers. During the summer of 1889 various experiments were carried out on a short length of the line then completed, by a temporary plant at Great Dover-street Station and two experimental locomotives. The experience gained in these trials was at the same time both unique and valuable, affording an amount of information which had never before been attained, and which proved invaluable in working out many subsequent details. In the meantime the construction of the plant proceeded rapidly. In close proximity to the Stockwell terminus of the line, on a large plot of land which serves as a general depot, a spacious engine-house, in which the entire current employed in working the line is generated, was erected.

The plant supplied consisted of three generating dynamos of the Edison-Hopkinson type, each having an output of 450 amperes at 500 volts. The machines are compound wound, with bar armatures, and are about the largest machines of the class that have ever been constructed, the total weight of each machine being over 17 tons. The driving is effected by means of link leather belts 28in. wide, and to increase the grip, the belt is led under a jockey pulley. Each dynamo is independently driven by a vertical compound engine, designed and constructed for Messrs. Mather and Platt by Messrs. John Fowler and Co., of Leeds. The high and low pressure cylinders are 17in. and 27in. internal diameter respectively, and are both steam jacketed. The stroke is 2ft. 3in., normal running speed 100 revolutions per minute, giving a piston speed of 450ft. per minute. The engines are fitted with automatic expansion gear on both high and low pressure cylinders, controlled by a high speed governor driven by ropes directly from pulley on crankshaft. The steam pressure employed is 140lb. per square inch. The flywheels are very massive—14ft. in diameter, 28in. wide on face, and weigh 14 tons. Each engine will indicate 375 h.p., and in practice two engines and dynamos are employed, and are sufficient to work the entire line, the third engine being kept in reserve. The engines are supplied with steam from six steel boilers of the Lancashire type, 28ft. long, 7ft. diameter, and are fed with fuel by means of Vicars's mechanical stoker. The water supply is effected by means of two Worthington pumps, and before entering boiler is forced through two feed-water heaters, heated by the exhaust steam from engines.

Since the opening of the line, and in view of the extension to Clapham Common, a fourth engine and dynamo similar to the original three have been erected, also two additional boilers. The boiler-house is below the general ground level, which greatly facilitates the stoking, the fuel being simply tipped straight into the hoppers, and so avoiding all cost for elevating, etc. Adjoining the engine house is a fitting shop where minor repairs can be carried out. From the dynamos the current generated is conveyed by means of lead-covered cables to a massive but simple switchboard, and is there distributed to the feeding mains. These mains or cables, of which there are four, are of the well known Fowler-Waring manufacture, and consist of a $^{61}/_{14}$ B.W.G. copper core, insulated with patent insulating material and lead-sheathed. The cables are carried on brackets along the sides of the tunnel, and led into the various signal boxes. In the signal-boxes are fixed small slate distributing boards, fitted with plugs and fuses, and from these the current is conveyed to the working conductor by means of feeder cables. The working conductor is of steel, of channel section, specially rolled for the purpose, and of such composition as to ensure its having a low specific resistance. It is carried by glass insulators, which are cleated with creosoted blocks to the sleepers, and laid between the two main rails at a distance of about 1ft. from one rail—this position being rendered necessary on account of the low position of the central buffer coupling. The lengths of conductor are fished with two small fish-plates and four bolts, as a mechanical coupling, while the electrical connection is ensured by means of a laminated copper strip secured by four copper rivets. The steel conductor is not continuous, but broken at every station. The intervening gap, a length of some 2ft., being made up with a piece of well-seasoned oak, by which means it is possible to isolate any one section of the line without interfering with the remaining sections, or, in case of any accidental failure occurring on any section, it automatically disconnects itself from the system. At the points and crossings, which are in every respect similar to ordinary railway practice, the shoes or collectors have to be lifted over the crossing rail, the level of the conductor being 1in. below that of the main rails. This is accomplished in a simple and effective method by means of inclined wooden planes, up which the shoes run. The insulation throughout the line is exceptionally high. The daily test of the entire system—which includes generators, switchboards, cables, feeders, working conductor, points and crossings, locomotives and lighting circuits with the full pressure of 500 volts—does not give a leakage current of one ampere, or considerably less than 1 h.p., and is often as low as a quarter of an ampere. The conditions of the line naturally are highly favourable in this matter, no difficulty with weather having to be contended with. The return circuit is made by means of the main rails, which are connected, in addition, to the ordinary fish-plates with copper connecting strips fixed in the same manner as in the working conductor.

The electric locomotives, of which 14 were supplied for working the line, were each designed to be capable of exerting a tractive force of 3,000lb., and running at a speed of 25 miles per hour. In general appearance the locomotives closely resemble steam tram motors. The weight of each locomotive is 10 tons, and it is carried on two axles with a wheel base of 6ft. In the construction of these motors a striking and novel departure from anything that had previously been attempted was made with regard to the armature. Instead of being, as in previous engines, connected with the driving axles by means of gearing, belts, or chains, the armatures were actually built up on the axles themselves, thus entirely obviating all the necessary incumbent complications that had hitherto been in vogue. The magnets are supported partly by the axles and partly suspended from the car itself, an arrangement which allows of a certain amount of freedom of angular motion round the axle, yet always remaining concentric with the armature. A separate and independent motor is fitted on each axle. The motors are series-wound,

and the armature revolution per minute, of course, varies with the speed of the train; at 20 miles per hour the revolutions are approximately 250 per minute. The current is taken from the working conductor by means of three sliding shoes fixed by hinged supports to the frame. The shoes are of cast iron, and it is found in practice that they will run about 10,000 miles before requiring renewal. From the shoes the current is carried by an insulated cable to the main resistance switch which controls both motors. The resistances are placed in series with the motors, and gradually cut out as the switch is put over. A second switch controls the reversing movement, which is effected by changing the direction in which the current passes through the armature. The locomotives are fitted with hand and air brakes, the latter being of the well known Westinghouse type, and continuous throughout the train. To work the air brake a supply of compressed air is carried in two steel reservoirs on the locomotive, and replenished at Stockwell on every round journey. Connection between the locomotive and carriages is effected by means of a central buffer coupling. The trains are made up of two coaches, each constructed to carry 34 passengers, open from end to end, with two longitudinal seats like those in an ordinary tramcar. Entrance into the cars is gained by means of end doors, and between the carriages intermediate platforms are fixed, fitted with collapsible side gates. The carriages, which are 29ft. over all, are carried on two four wheel trucks, and, exclusive of passengers, weigh over seven tons each. The lighting is effected by means of incandescent lamps, supplied with current from the working conductor.

The gauge of the line is standard 4ft. 8½in., and the rails, 60lb. weight per yard, are of Ebbw Vale steel. The track is not ballasted, the cross sleepers merely resting on the sides of the iron tunnel. The road has many severe curves and gradients, the sharpest curve having a radius of 1½ chains, and the heaviest gradients 1 in 14 with, and 1 in 25 against, the load.

A complete telegraphic and block signalling system is carried throughout the line.

Such is a brief description of the line and its equipment, the entire electrical portion of the latter being constructed by Messrs. Mather and Platt, of Manchester, from the designs, and under the superintendence, of Dr. Edward Hopkinson, a partner in the firm.

A few words on the working and results may, perhaps, be of interest. On November 4, 1890, the line was formally inaugurated by His Royal Highness the Prince of Wales, who, accompanied by His Royal Highness the late Duke of Clarence, made the journey from the City to Stockwell and visited and inspected the plant and works. Shortly after this the line was passed by the inspectors of the Board of Trade, and eventually opened for public traffic on December 18, 1890.

Upwards of 18 months have therefore elapsed since the public opening, during which time the line has been in daily operation. For the first few months a train service of some 12 trains per hour each way was maintained, but with the growing traffic this has been increased, until at the present time, during the busy hours of the morning and evening, as many as 16 and 17 trains per hour are run. The public appreciation of the line is shown by the increasing numbers of passengers carried. For the half year ending June 30, 1891, the number of train miles run was 141,108, and passengers carried 2,412,343. For the second half-year, ending December 31, 1891, the train mileage run was 188,666 miles, and passengers carried 2,749,055, exclusive of season ticket holders, the revenue from which on the average fare would represent 37,300 additional passengers, or a total of 2,786,355. The revenue receipts and expenditure have been—for the first half year, receipts £19,637, expenditure £15,520, or a balance to the good of £4,117; for the second half year, receipts £20,243, expenditure £15,516, balance to the good £4,727. These figures are significant when compared with the train mileage and passengers carried, 47,258 train miles more having been run, and 374,000 more passengers carried during the second half year, while the total expenditure has been £4 less, which reflects much credit on both the general manager and engineer, Messrs. T. C. Jenkin and Basil Mott, for the manner in which the working of the line has been conducted. It is to be regretted that this meeting was not a few weeks later, when the results of the present half year would have been available for comparison, but to date, since the opening of the line, the total mileage run is over half a million miles, and the number of passengers carried upwards of seven millions. The percentage of expenditure to receipts may appear high, but careful study and analysis of the figures show that this is not abnormally due to the traction expenses—the cost of locomotive and generating power, including salaries, office expenses, general superintendence, running expenses (including wages connected with the working of locomotive and generating engines, coal and coke, gas, water, oil, tallow, and other stores), repairs and renewals, including wages and materials, only amounting to 40 per cent. of the total expenditure, or 30 per cent. of the gross receipts, which I venture to submit will compare favourably with any other mode of traction. From these figures it will be seen that the cost per train mile for the last half year was just under 8d., while under the sliding scale before mentioned the cost per train mile on the mileage run would have been 7·125d. But in the actual cost of 8d., drivers' wages and other items are included, which were excluded in the sliding scale, and if deducted, bring the actual cost down to 5¼d. per train mile. This, I think, will be generally admitted as highly satisfactory, especially when the serious increase of the train load (no less than 40 per cent. above that originally stipulated for) caused by the increased weight of carriages is taken into consideration, the total train load for the 5¼d per mile being 42 tons. The working of the plant and line has been both regular and satisfactory.

On no single occasion during the whole period that the line has been in operation has there been any accident or stoppage of the generating dynamos, showing conclusively the security and certainty with which electrical plant can be worked. Slight delays have occurred from time to time with the locomotives, but these have in almost every instance been distinctly due and traceable to the unexpected load and strain put upon them, and in spite of which the record of work done by these locomotives will compare favourably with that accomplished by steam locomotives. The average mileage of the locomotives in regular use during the past year has been no less than 27,000 miles, while on a well equiped steam road the average is 20,000 to 23,000 miles per locomotive. The success of the line is further shown by the numerous similar projects which have followed. Last year a Bill was passed through Parliament authorising the construction of the Central London Railway, a line seven miles in length, extending from the City to Bayswater, to be constructed in the same manner, and to be worked electrically on similar principles, but on a much larger scale. During the present session no less than six Bills have been presented applying for powers to authorise the construction of similar undertakings. Of these six Bills, four of which are applications for new lines, and two for extension of existing powers (including the extension of the City and South London line to the Angel, Islington), three have passed through both Houses—viz., the Baker-street and Waterloo line, the Great Northern and City line, and an extension to Liverpool street of the authorised Central London line. The Great Northern and City line, running from Drayton Park to Finsbury-pavement, is of exceptional interest, being intended to relieve the Great Northern traffic, and over which it is proposed to run the ordinary rolling-stock of the Great Northern Railway. The above Bills in the first instance were referred to a Joint Committee of both Houses appointed to consider the whole question as to the best method of dealing with the electric and cable railways schemes, and to report their opinion as to whether underground railways worked by electricity or cable traction are calculated to afford sufficient accommodation for the present and probable future traffic. The Joint Committee, after having met on several occasions, and having had submitted to them a large amount of evidence, reported strongly in favour of the various schemes, and with regard to electric traction, as follows:

"The committee report that the evidence submitted to

them was conclusively in favour of the sufficiency and special adaptability of electricity as a motive power to the proposed underground tubular railways."

It may therefore be assumed that before very long this system of transport will become fairly general in London, affording as it does a cheap, rapid, and safe mode of conveyance.

On the table is a small model of the Bessbrook and Newry motor-car; also a model locomotive of the same power as the City and South London line and but little more in weight, with Hopkinson's patent double motor, in which a single magnetic circuit embraces both armatures, the motors being carried entirely from the framework, and therefore on springs, and driving the axles by diagonal connecting-rods, according to a plan devised by the late Mr. Lange, of Messrs. Beyer, Peacock, and Co., Limited. The photographs round the room are various views of the plant, etc., of the Bessbrook and Newry and the City and South London lines.

Mr. SCOTT RUSSELL asked why a separate motor had been adopted. He thought otherwise a great deal would have been saved and greater adhesion obtained. He considered that all concerned in the City and South London line deserved the greatest credit for the success achieved.

Mr. A. J. JARMAN said that when the armatures were wound on the axles, the latter were turned into part of the magnet with the wheels, thus forming the pole, and clinging to the rail; hence, no sand was required to assist in starting. Another point was why the motors were wound in series. Supposing that one of the main wires become cut or broken, that motor would stop. If, however, the motors were wound in parallel, there would always be one leg of the field magnet to work, but worked in series with series winding that motor would be cut out. Winding in parallel had many advantages over winding in series in working the machine on gradients. He was alluding to tramcar traction, and he considered it would be more advantageous to wind the motors in parallel than in series.

Mr. RECKENZAUN stated that great credit was due to all concerned in constructing the City line, which was the pioneer line in that direction. With regard to operating expenses, he thought Mr. Grindle would have given details; how much was paid for coal and wages, etc. Taking 5½d. per train mile, the working expenses seemed very low indeed. He agreed with Mr. Jarman that if two motors on a locomotive or tramcar were placed in series, there was a possibility of their not working in union; if in parallel they worked together, and in case of accident one automatically cut itself out of circuit.

Mr. HOLROYD SMITH supported the remarks of Mr. Jarman and Mr. Reckenzaun on the matter of parallel working. From his own experience he had found a decided benefit by coupling up in parallel. It would be interesting to know the cost of producing one Board of Trade unit on the line. He would like to know whether any measurements had been taken to ascertain the relation between the electrical power put in the line and the mechanical efficiency obtained from it. Mr. Scott Russell had referred to the motors not being placed under the cars themselves. He (the speaker) said that if Mr. Russell had had the details of the line to thrash out he would have found that it was impossible to do so in that case. When the matter was fully taken into consideration, Messrs. Mather and Platt had decided upon the only safe way, considering the structure of the line, tunnel, cars, etc.

Dr. E. HOPKINSON, in reference to the separate motor or otherwise, said that in the case of the City line there was the difficulty of putting the motor on the bogie due to the restricted space, but that was a mechanical difficulty which could have been overcome with sufficient application. The total weight of the locomotive was 10 tons, and of the train 50 tons. Of the 10 tons the motors weighed six tons, and the saving by not having a separate locomotive would be four tons out of the whole 50 tons. If, however, the motors were placed on the framework, the bogie would have to be strengthened and made heavier, and the total saving would only be about two tons. Under those circumstances it was not worth while to do so, and that was ample justification of the plan which had been adopted on the South London line. Mr. Grindle, who came to his firm in Manchester seven years ago, suggested that that railway was the place for electrical work. That gentleman urged them to turn their attention to it, and the result was the working out of the details. With regard to having the motor in series or in parallel, from an electrical point of view there was nothing to choose between the two. It was a great mistake to suppose that having the motors in series would reduce the risk of a breakdown.

Mr. JARMAN stated that what he meant was that each pole of the field magnet should be wound so that they might be coupled in parallel and joined in series afterwards. That might be something new in motor work, but he had found it of great benefit in tramway work.

The next paper read was by Mr. L. EPSTEIN on

ELECTRIC TRACTION FOR TRAMCARS.

If possessed of no other merit I hope I shall be able to claim for my paper the merit of brevity, and I will endeavour to cover within the short space of time allotted to me—viz., 20 minutes—as long a line of track as the system of accumulators, which, with your permission, I am going to bring under your notice, will permit me. I will, to use an electrical expression, discharge my paper at a very high rate.

Having occupied myself for the last 12 years almost exclusively with the study and manufacture of secondary batteries, I had arrived, about two years ago, at a point which, not only by myself (who might be accused of the sanguine feeling inherent in inventors) but also by others upon whose common sense and clear judgment reliance may be placed, is considered to be as near perfection as any contrivance may be said to be. I have the pleasure of showing you here one of the accumulators which are specially adapted for propelling tramcars or other vehicles. You will see that this accumulator, unlike other cells, is composed of only three electrodes, which are contained in an ebonite box. There is no paste used in the manufacture of these cells, but the parts which are active—that is to say, which take up and give out again the electrical energy put into them—are produced out of the original substance of the lead itself.

To those gentlemen who take an interest in this matter I can show some plates here in the different stages of manufacture. The great point is that the so-called active material cannot by any possible means become detached, and that therefore there is no risk of material dropping off and damaging the accumulators when in use. There is also no danger from warping of the plates, which, as you will see, are very thick and robust, and therefore well adapted for the work for which they are intended. One of these cells complete, with acid, weighs about 45lb., and as generally 96 cells are used on a tramcar, the weight of the battery complete is a little under two tons, or about one-fifth of the total weight of the car, which, with its full complement of passengers, is a little over 10 tons.

This battery of accumulators will allow the car to run at an average speed of 7½ miles for about four hours, leaving a sufficient reserve in the accumulator to provide for any unforeseen emergencies. This running for four hours is under the assumption that the average expenditure of the battery is about 6 h.p., and the weight of the battery corresponding to 1 h.p. is, therefore, about 750lb. But if it should be desired, this battery can be discharged at twice the above rate, in two hours—that is, if provisions are made to exchange the batteries every two hours, the battery can be made to give out 12 h.p.—therefore the weight of the battery corresponding to 1 h.p., is, in this case, only about 370lb.

These accumulators have the further advantage that, if not required, they may be left idle for any length of time, without incurring expense. They are in this respect more economical than horses, which, as you are only too well aware, require fodder and attendance whether doing work or standing idle. Or, again, compared with horses, accumulators may lay claim to a much more certain and satisfactory state of health—glanders, skin diseases, pink eye, and other contagious diseases being unknown among them.

The further advantages are that the roadways are kept clean, there is no dirt or smell, and the cars are lighted at

the same time from the accumulator in a much more efficient manner than is the case now.

I am afraid I have already taken up too much of your time on matters relating solely to accumulators, and I will therefore pass to another point which may prove of more general interest. I am alluding to the question of £. s. d., and I will, with your permission, briefly glance at the cost of tramway traction by means of horses and the same by means of the accumulators which you see represented here by this cell.

The experience gained in the United States, and also some towns in England, has shown that an electrically-propelled car can complete several more runs per day than a horse car, as not only can they run faster, but the rest required by horses is of course absent in the case of electricity, and it has been found that electrically propelled cars have a proportionately higher earning capacity.

I have prepared some tables which will enable you to compare at a glance the relative merits of the two systems. In this table* (Table A) the costs of working a car mile find expression. You will see that if we call the cost per car mile worked by horses 100, the cost per car mile of the same line, if worked by means of our accumulators, is expressed by the figure 67, or, in other words, that a saving of about one third is effected in the latter case.

The next table, Table B, shows graphically the percentage of total working and general expenses as compared with total receipts. If we express the total receipts by the figure 100, the total expenses in the case of horses amount to a little over 75 per cent., while the total expenses with accumulators only amount to about 54 per cent. While, therefore horses, appropriate more than three quarters of the total receipts, the equivalent figure with accumulators is only a little over half.

In Table D the balances available for dividends are shown, and, as will be seen, the £50,000 available with horses are increased to £141,000 in the case of accumulators. The last table (Table D) shows a comparison of the dividends – 8½ per cent. in the case of horses, and 25 per cent. in the case of accumulators.

I am aware, gentlemen, that these figures will, perhaps, meet with some doubt, and that the remark will be made that however well they may look upon paper, very different results may accrue when put to actual test, but there is really no reason to doubt that these figures – at least, very nearly – express the truth. The cost of not only the accumulators, but the whole of the electrical installation has been carefully worked out, and will stand the test of rigid examination. If the estimate errs at all, it will, I think, be found to err on the safe side.

Now with regard to the expenditure. The cost of working is based on figures derived from actual running. The cost of fuel is well known. The depreciation of the boilers, engines, dynamos, and motors is liberal; therefore, the only item that might be open to doubt is the cost of renewal of the accumulators, but also on this point I think proof can be adduced that the estimate is a safe one. Our accumulators have been tested under conditions which are much more severe than those which they will encounter when in use on a tramway. They have been discharged at much higher rates, they have been left idle both after a charge and after a discharge for periods up to three months – all this without being damaged, so that there is really no reason to anticipate that the cost of maintenance will be more than, at the outside, 1d. per car mile.

Looking at it from the point of view of the manufacturer, this can be further explained by the fact that where accumulators of this type are being used, they only require the renewal of one plate, which plate is produced by casting, and as the lead of the old plate is recoverable, only a very little additional expenses for loss and wages is incurred.

Before concluding, I will just glance at the relative merits and demerits of the accumulator system and the overhead or trolley system, and the system of underground conductors. These systems can claim a less weight of car, but this is the only advantage as far as the trolley system is concerned; while, on the other hand, it possesses many, and some very great, disadvantages. Among them may be mentioned unsightliness of the overhead structure, the danger consequent upon the snapping of a wire, the impediment in case of frost (when the wires are frequently covered with a thick crust of ice, and the trolleys, therefore, make very imperfect contact), and the flooding of the rails (conveying the return current after heavy rains, when special cars have to be sent out to sweep the roadway).

The first cost of the two systems is about the same, but the efficiency of a good accumulator system is far higher than the efficiency of a trolley system. A calculation based on the working of the different lines on the trolley system in the United States has elicited the remarkable fact, that the efficiency—viz., the proportion of the brake horse-power on the car motor, as compared with the indicated horse-power at the generating station—amounts in some cases to only 25 per cent., and exceeds in no case 40 per cent. in everyday practice, or an average of 32 per cent.

The correctness of these figures will be easily recognised when we bear in mind that the generating station must be capable of furnishing the maximum current at any given moment, while the average current falls far short of the maximum, and as it is well known an engine works most economically near its maximum load, and less and less economically with a decreased load, the correctness of the figures, which at first sight may appear rather startling, will soon become apparent.

Although I have not so many figures at my disposal regarding the efficiency of an underground system, yet, as the conditions of working are almost identical with those on the trolley system, there is no reason to assume that the efficiency of such a system is any higher. A further great disadvantage of the underground conductors is that the construction of the line is very expensive. Both systems, the trolley as well as the underground, have the great disadvantage that where existing lines are to be converted into electrical lines the conversion interferes with the existing traffic—in the case of underground conductors much more so than in the case of the trolley system; while, on the other hand, provided only that the rails are in good condition, a horse line may be almost instantly converted into a line driven by means of accumulators.

With an accumulator system the efficiency is much higher than with either the trolley or underground system, and it will, I presume, interest you to learn the results of some experiments which were carried out at our works, under rather severe conditions. The batteries were discharged in three hours, and were charged again in three hours, without the use of any intermediate resistance, thus utilising the whole of the current for the battery. We found that it was only necessary to charge the battery with a current that exceeded the previous discharge by 5 per cent., and the efficiency—that is, the total energy given out as compared with the total energy put into the cells—under these very trying conditions was still as high as 78 per cent. Allowing for loss in dynamos, gearing, and motors, we arrive at the efficiency of 63 per cent. between the horse-power generated by the engines, and the brake horse-power on the car motors, and allowing 25 per cent. for the increased weight of the accumulator car we arrive at a total efficiency of 47 per cent., as against 32 per cent. of the trolley system. The explanation may be found in the fact that in the case of accumulators the central stations, which need not be so large as in the case of direct current, can always be used at their full capacity, no fluctuations of the output taking place, and the engines working much more economically.

Another great advantage is that each accumulator car is self-contained and independent of the central station, so that any breakdown at the central station does not interfere with the working of the line, while with the direct current, whether it be conducted to the car by means of overhead wires or underground conductors, an accident at the central station may interrupt the traffic on the whole of the line, and bring all the cars on the road to a standstill.

I hope to be able, at no very distant date, to supply you with figures derived from the actual working of our accumulators on different tramways.

* These were coloured diagrams, which the text fully explains.—

Mr. CARRUTHERS WAIN remarked that Mr. Epstein had made some statements in his paper which he would like to see practically carried out.

Mr. H. W. BUTLER, of the Electrical Power Storage Company, stated that his company could bear out all that Mr. Epstein had said as regarded the efficiency and useful work. He was always glad to find other people working in the same direction as the Electrical Power Storage Company. The latter was prepared to undertake the maintenance of accumulators at a very reasonable figure, according to the amount of work they had to do and the grades of the lines. Any tramway engineers who were sceptical as to the renewals question could rest assured as to the expenditure on that item. The tests made by Mr. Epstein were no doubt very stringent, and he doubted if the efficiency mentioned could be maintained.

Mr. RECKENZAUN said that Mr. Epstein's paper was very interesting as regarded the paper figures, but it contained nothing but hypothetical statements. He believed the accumulator to be a good one, but it had never been tested on a tram line. That battery might give 78 per cent. in the laboratory, but not in practical work. He believed that with the best modern appliances the average efficiency would be from 35 to 40 per cent. Statements made of 47 per cent. efficiency between car axle and steam engine were much exaggerated. He believed there was a great future for an accumulator which cost only 1d. per car mile.

Mr. L. EPSTEIN, in reply to Mr. Carruthers Wain, stated that his company was prepared to supply and maintain accumulators at a fixed sum for a certain time. The efficiency of 78 per cent. was arrived at when the accumulators were charged in three hours without any regulating assistance. The efficiency, when charged in five hours, was 82 to 84 per cent.

The last paper was presented by Mr. A. J. JARMAN, A.I.E.E., on

ELECTRIC TRAMCAR TRACTION.

Twelve months ago I had the pleasure of reading a paper before you upon that method of electrical traction that bears my name, and after giving you a detailed description of the mechanism and storage battery connected with this system, I promised to give some further information upon the practical working of the battery when we met together again. I am now able not only to give you some information respecting the everyday working of my patent storage battery, as well as that of another well known make, but also about the working of the electric motor, gearing, etc., which I fully described to you just a year since.

Towards the end of last year an agreement was entered into with the Croydon Tramways Company for the running of electric cars fitted under my patents. It was contemplated to run a regular two-car service, but with only two cars at my disposal, one alone could be kept in regular work; it being necessary to have one car ready to take the place of the other, when this had to be taken to the charging station to recharge the batteries. Had the charging station been at the end of the line a two-car service could be maintained, and time kept with three cars, but, situated as the charging station is, in the middle of the line, it would require four cars to maintain a regular two-car service, but these four cars could, with the depôt at either extremity of the line, maintain a three-car service, allowing one car in reserve. Before entering upon the account of the work done, I may state- and I trust the chairman of the Croydon Tramways Company may not disagree with me—that the conditions under which the running took place were not the most favourable. The flanges of the car wheels were too deep for the rails, and had to be ground down in running before the cars could run smoothly, the tread of the wheels being three sixteenths above the rails owing to the wheels having been made to suit another section of tram rail; the points, also, were not good enough for the electric cars, which would not occasionally take the points and consequently run off the line. These circumstances, as you understand, were not favourable to the cars, and much extra power was consumed and the motive machinery was subjected to strains which would not have come upon it on a line prepared for electric traction.

The first car commenced to run in everyday service in January of the present year, and ran for several weeks, carrying a considerable number of passengers—I remember on one occasion as many as 84. Well, after several weeks running, the vulcanised fibre teeth (which I used in my gearing wheels and which I adopted with a view to noiseless running) gave way, the mishap occurring through reversing the electric motor, and bringing the car up to a dead standstill whilst running at its normal speed so as to avoid running over a horse which had strayed across the tram line at night, and at a very dark part of the road; the life of the horse was saved at the expense of the car gearing. On examination of the wheels fitted with the fibre teeth, I came to the conclusion that these teeth were not adapted for everyday work. Upon careful examination it was found that these teeth had commenced to laminate, the lamination being caused through their running constantly in oil, to keep them well lubricated. In all the previous experimental runs, extending over a year or two, a mixture of tallow, lard, and plumbago was employed as a lubricant, and with this lubricant no defect was observed to take place with the fibre teeth. I took out all the vulcanised fibre teeth and replaced them with hard gunmetal; these teeth worked well, and I did not observe any perceptible increase in noise by their adoption. Last Easter Sunday one of the cast-iron mortice wheels fitted with these teeth broke in the main body into four pieces, all the gunmetal teeth remaining intact. I cannot now avoid coming to the conclusion that cast iron in any shape or form is not suited for the gearing of self-propelled vehicles, no matter how thick it may be employed.

Cast iron cannot withstand the shock and concussion which it must inevitably be subjected to in tramway work. Cast-iron mortice wheels were used only in the gearing of No. 1 car, not constructed by me; the gearing in No. 2 car, which was designed and put together entirely by me, was fitted with wheels cast in phosphor bronze, known as No. 7 alloy, and these wheels I have found to perfectly withstand the shock and strain incurred in tramway work, so far without becoming brittle or crystalline in their structure. Although I had allowed ¼in. for the side play of the mortice wheels and wrought-iron pinions, it has been found from everyday practice that a greater space should be allowed, particularly for the rounding of a curve, and the occasional crossing of the wheels when running over very much worn points, and this practical result leads one more than ever to adopt the simple and plain form of tooth for gearing which I have always advocated in place of either helical or worm gearing, as the side play of the car axle must impose a considerable side thrust upon the worm wheel and screw, and upon the sides of the teeth in helical gearing, and result in great friction, and consequent loss and waste of power.

There cannot be any doubt that some tram lines are very much heavier to run upon than others, particularly so where the groove in the rails is shallow, and becomes filled with dirt, thus absorbing an enormous amount of power in grinding the dirt to powder through the difference in the circumferential velocity of the flange of the car wheel to that of the tread. This applies to every method of traction upon tramways where a flanged wheel and grooved rail is used. The phosphor-bronze alloy of which I have spoken is capable of bearing a strain of 16 tons per square inch, and the gunmetal teeth 14 tons per square inch, these latter teeth working very satisfactorily with a wrought-iron pinion when kept well lubricated by dipping into the well-known green oil so much used for tramcar axles.

Having given you my experience with the gearing of the cars, I wish to say that it has been with this part of the mechanism that the principal difficulties have been experienced, and now this difficulty has been entirely overcome. I now come to the electric motor, and this, like the gearing, has been put thoroughly to the test, and I am very pleased to say it has withstood all the strains of everyday work that have been imposed upon it. It is true that one armature had to be renewed through defective insulation, but this was in car No. 1, the motor of which, as I have before mentioned, was not made by me. In every other respect

the motors have proved themselves perfect for tramcar work. Notwithstanding the heavy loads of passengers they have occasionally moved, they have been enabled to keep the cars up to their running time, and not interfere with the horse traffic, thus proving that they are equal to the task imposed upon them in carrying their loads, keeping time, and being both electrically and mechanically efficient, and demonstrating what is of vast importance to tramway companies—viz., that an efficient accumulator system enables the companies to gradually change the system from horse to electric traction without being burdened at the outset with the enormous capital outlay necessary for an installation by the direct-current system; at the same time my electric cars are equally applicable to a line worked by direct current. My patent carbon brushholder and the method of feeding the carbons as they wear away has proved itself a success in every particular, running for six weeks without renewal of carbons. An efficient little piece of mechanism like this is of the utmost importance where the electric motor is employed for traction purposes, as it enables the motor to run quite sparkless at the commutator.

I now come to the storage battery, and as I promised a year ago to say something about this much abused and less understood electrical accessory I will redeem my promise. It is but a few years back that the cost of traction by accumulators was an unknown quantity, but to-day all is changed; in fact, I think I may say that the cost of accumulator traction has become a known quantity since my paper was read before you 12 months ago. You will remember, in the concluding statement of that paper, I said "the cost of maintaining the batteries in an efficient state, from what I have before mentioned, I do not think will exceed in a large installation 1d. per mile." Speaking now from experience, I estimate the depreciation and renewal cost upon 104 battery elements, being the number used in my cars, at 1d. per car mile run. If confirmation is required of the correctness of my estimate, I think it is afforded by the fact that a large firm of storage battery makers are prepared to maintain the batteries they supply for traction work at a penny per car mile run, with some small percentage upon receipts or profits, thus amounting to just about 1¼d. per mile for depreciation, and this only goes to support the calculations I made a long time previous, and also what I have been able to ascertain in practice upon the Croydon Company's line.

There has not been a single battery element renewed in either of the two cars at Croydon from the day they started running, and I am strongly of opinion, based upon observation, that there is more harm done to the storage battery when standing idle than when it is in daily use, because the acid solution has more time to act chemically upon the spongy metal, and the subsalts that are formed, than it would do in everyday charging and discharging. I attribute in a great measure the lasting qualities of the accumulators in these particular cars to the good quality of the electric motor, and to the fact that the flow of current is small compared with other motors to start the loaded car from the state of rest, and thus the cells do not become over-discharged, as has been the case hitherto. My motor has been designed to suit the storage battery and to make it enduring, and practice up to now has confirmed my contention that I have attained this desirable end.

I now come to that part of the subject with which you all are more interested, and that is, what does the accumulator system cost to work, and will it pay? Upon this point I will be as exact as I can, basing my estimation upon actual practice, because I do not want you to suppose that my enthusiasm is so strong as to lead me to think that because a tramcar can be moved and propelled by electricity that that is all that is desired, nor to think that all the horses are to be wiped off the face of the earth because the question of electrical traction has made such great progress; I have stated before, and I state again, that this method of traction by electricity will stand only by virtue of its commercial value. Now the principal items of cost are: 1. Fuel. 2. Renewal of batteries. 3. Wages. 4. Repairs and renewals—oil, grease, and stores.

Now I found from experience at Croydon that the fuel consumed, using a double-cylinder, high-pressure portable engine (an expensive consumer) was 1½d. per car mile run on a wet day, up to 2d. per car mile run on a dry day. With dear fuel and such an engine, this cost is far higher than would be the case with a modern-type engine and running a number of cars. As to the cost of fuel, I think we may safely take the figure named in the *Electrical Review*, 20th February, 1891, as to the cost of fuel on the Barking line—viz., 1·033d. per car mile run over 100,000 miles. The wages per car mile run I am unable accurately to fix, but as the wages on our large horse tram lines, where necessarily a large number of men are employed as horsekeepers, etc., amount to less than 1d. per car mile run, we may be certain that the wages on an electric line would be far less. The cost per car mile of the renewal of batteries I have already treated of. The miscellaneous expenses, such as depreciation and repairs, oil, grease, etc., I will put down at another 1d., and in stating this figure I am again supported by the published figures of the Barking-road running before alluded to, although more than half of this 1d. per mile—viz., ·599d. per mile—comprised in that instance repairs to motors and gearing, a rate which I may confidently state would not be reached with my system. We have thus per car mile run:

Fuel	1d.	Total 4¼d. per car mile run
Renewal of batteries . .	1¼d.	
Wages	1d.	
Renewals, repairs, and sundries .	1d	

One thing has been found at Croydon, and that is the public take to these electric vehicles. They like the easy riding; they like their rapid travelling, which so often has enabled persons to catch their trains; they like the well lighted interior and the general advantages these cars offer. Considering, moreover, the fact that they carry heavier loads of passengers than horse cars, it is evident that they can be made to pay well upon the lines where they may be adopted where horse cars would not pay, and that 90 miles per day could be run by these cars just as well as 70. There are many tram lines in this country that never have been worked at a profit and never will be where horse traction is employed. Those that have invested their capital in the laying down and equipping of these lines have long seen that their salvation lies in cheaper traction. I am convinced that if there is one force more than another that will prove effectual in accomplishing this desired object, that force is electricity.

Unforeseen difficulties always have arisen in the development of every invention and industry. We all have to learn and be taught by that one great master—experience. The self-contained electric car embodies all the elements for successful working. It matters little what may have been done in the past or what errors may have been discovered in the early stages of experimental work for the propulsion of tramcars by electricity. Depend upon it, the time will assuredly come when the accumulator car will take a firm footing upon our tram lines because of its many advantages over every other form of traction.

In the evening of Tuesday the members inspected the Electrical Exhibition at the Crystal Palace, where the annual dinner subsequently took place. On Wednesday a party of members visited the City and South London Railway and inspected the electrical plant and generating station; and afterwards they witnessed some experiments with the Connelly motor at the depôt of the London, Deptford, and Greenwich Tramways Company, at Deptford.

Cheap Batteries.—We hear accounts of experiments with a coal battery—that is, a battery using up coal in its solution—from an enthusiastic inventor who thinks he has got hold of the right thing at last. We should like to have the results of the tests. We have further been favoured with the sight of the patent by Harris and another (not Mark Twain) of the arrangement for producing what we have termed "tinpot" electricity. Water forced slowly through a brimstone diaphragm fixed in a tin vessel will, says the specification, produce a difference of potential by simple molecular action. It would be certainly interesting to see it done.

STEAM AND GAS ENGINES AT THE ELECTRICAL EXHIBITION.

The display of electrical applications in the Crystal Palace Exhibition shows the great importance of the part played by the various kinds of motive-power engines which are employed in driving the many types of electrical generators. The steam engine still occupies the most prominent position, but gas engines are only second for this work. Almost all the makers of this type of motor are represented, and it is clear that for a large proportion of all the smaller electric lighting installations the gas engine is and will be used. The effects of the variation in rotative speed have to some extent been eliminated partly by the adoption of much higher engine speeds, and partly by the use of flywheels on the electric generators which they drive. Where very great regularity is required or deemed to be very essential the steam engine will long continue to be the favourite motor, but the advantages which attach to the gas engine will in very many cases outweigh very great precision in this respect

The time is no doubt rapidly approaching when economy in cost of working will be added to the other advantages which the gas engine offers, and it is conceivable that future improvements will enable the gas engine to be run with much greater regularity in rotative speed than at present. To those causes of improvement in this respect will probably be added greater precision in governing and a more general employment of systems of working which secure impulse at every revolution, or possibly at every stroke. All these systems of working are even now represented by engines in the Palace, and experiment and experience will, no doubt, gradually point the way to obtain the greatest economy with engines which also secure the greatest regularity. While remembering that the steam engine is, for large powers, still the most economical motor, it has to be admitted that the gas engine supplied with heating-gas made specially for the purpose—as, for instance, on the Dowson system—is the most economical motor yet made, even for very large powers. The steam engine cannot be relied upon to give an indicated horse-power for less than 14lb. of good coal. The gas engine, with Dowson gas, and of not less than 20 h.p., can now be relied upon to give an indicated horse-power for 1·2lb. of coal, and gas engines are being made which are capable of giving off approximately 100 h.p. At present, the only objection to the gas-making plant for this purpose is that it involves attention which corresponds with attention to a steam boiler. The oil engine, which is now beginning to take an important place among small motors, is not represented in the Exhibition, apparently because these engines cannot at present be worked without giving rise to disagreeable smells, which, though not sufficient to prevent their use in many places, would be objectionable in a building like the Crystal Palace. No other cause for their non-appearance in the Palace can be assigned, inasmuch as oil engines are now made which employ oil having a high flashing point. The only other type of motor at all extensively used for driving electrical generators which is represented in the Palace, is the turbine. For these and other hydraulic motors there is no doubt a prospective field for electrical work in Scotland and Ireland, and to a smaller extent in England, but not sufficiently immediate to make it necessary to refer at length to them now.

The steam engines comprise almost every type commonly applied in electrical work, including the single-acting engines, both compound and triple, represented particularly by the engines which Messrs. Willans and Robinson have made so popular; the ordinary double-acting engine with single cylinders and compound, represented by the engines of the Brush Company, Easton and Anderson, Scott and Mountain, Ronald Scott and Co., Holmes, and several others, as already illustrated in our issue of April 29. The triple-expansion engine is well represented by the fine engine of Messrs. Davey, Paxman, and Co., coupled direct to the large eight-pole Johnson and Phillips central station drum armature machine running at 130 revolutions per minute, as illustrated in our columns of April 15 last. This is a remarkably well-made engine of the marine type, with cylinders of 12in., 18¾in., and 30in. diameter, all with a stroke of 18in., the engine indicating 350 h.p. with steam at 160lb. pressure, when running at its intended speed of 140 per minute. Working at its proper load, this engine would probably give an indicated horse-power for about 15lb. of steam at the pressure named. It is fitted with Paxman's double valve and link cut-off controlled directly by a governor, which secures great precision of cut off and regularity of speed and rotation. It forms one of the chief features in the steam-engine part of the Exhibition, but there are numerous other steam engines of a different but nevertheless important kind, to which we must refer at length in a future issue. They include the Willans central valve engine, one of which was illustrated in our issue of the 29th of April; the engines exhibited by the Brush Electrical Engineering Company, by Messrs. J. H. Holmes and Co., and several others.

Amongst the gas engines to which a very high place must be given, must be mentioned the high-speed engines of various sizes exhibited by Messrs. Crossley Bros. These engines work on the well-known Otto cycle, but are specially designed to run at a high speed, so as to secure regularity of rotation, and are provided with governor gear and timing valve to suit them for electrical work. These engines are, we may further mention, now fitted with self-starting gear, by means of which engines, even of considerable size, may be started without difficulty. A different type of gas engine is shown in several sizes by Messrs. Campbell and Co., of Halifax; still another type by the Griffin Gas Engine Company; another by the British Gas Engine Company; another by Messrs. Day and Co.; and another by the makers of the Stockport engine. All of these are of different types, and we must postpone reference to them to another issue.

LONDON COUNTY COUNCIL.

At the meeting of the Council on Tuesday the adjourned report of the Highways Committee on the Victoria-embankment lighting was considered. The report says: "Our attention has been directed to the defective lighting of the Victoria-embankment, and especially of the carriageway, and for some time past we have had under consideration the desirability of substituting electricity for gas as the illuminant. In connection with this substitution the first question that presents itself is what method should be adopted to provide the supply of electrical energy; and three courses appear to be open for adoption—viz., (a) to obtain the supply from the companies authorised to supply within the areas in which the Embankment is situated; (b) for the Council to lay the mains and provide and fix the lamps, and then to obtain the supply from one of the companies; and (c) for the Council to instal the necessary plant on its own land and to light the Embankment by means of an independent installation. The first course (a) is open to the objection that three several companies would have to be dealt with—the City of London, the Metropolitan, and either the London or the Electricity Supply Corporation—and considerable complication might arise, as one part of the Embankment might be efficiently supplied, while others might not, and, moreover, as each company would have to lay mains for the portion within its own district the cost might be increased. The second course (b) is open to the objection that although the Council would provide the mains, and would not apparently be prohibited from carrying the current from one company's district to another, the other companies might consider that this course, although probably legal, was straining the strict interpretation of the Acts. The third course (c) appears to us to be the proper one for the Council to take, having regard to all the circumstances. The first capital expenditure would, of course, be greater, but the cost of maintenance would probably be less, and the adoption of this course would accord with the principle which has been affirmed by the Council of the carrying out of work by its own staff when practicable. Should the Council decide to adopt the electric light as the illuminant for the Embankment, we propose that lamps of from 1,000 c.p. to 1,200 c.p. should be placed in the centre of the road at about 50 yards from each other. About 30 of these lamps would be required for the carriageway, some few of which at important points might be of a higher illuminating power; and the supply of the electric light might also be extended to the existing lamps on the parapet walls, and, where necessary, to those on the footways. The generating power required for this installation might conveniently be placed upon the land belonging to the Council under the Charing Cross railway bridge; and for the purpose of ensuring against the extinction of the light through the failure of any part of the machinery, and also as an economical precaution, the light should be placed on two independent circuits, an engine and dynamo being provided for each circuit, and a third engine with dynamo being kept in reserve to be available, if required, for either circuit.

Steam could be supplied by a boiler of the locomotive type, and a second boiler should be kept in reserve for use if required. The mains could be so arranged that at midnight, or at any other time that might be fixed for the purpose, the lamps on one circuit could be extinguished leaving the Embankment less brilliantly but yet sufficiently lighted. Upon the question of cost, we are advised that the capital expenditure if the above arrangement were adopted would probably not exceed £10,000, while the cost of maintenance, including depreciation, repair, and interest on capital, and also providing amply for labour, would probably not exceed £2,000 per annum. It may be stated that, with a comparatively small increase on the capital expenditure above stated, provision might be made for the lighting of the Embankment gardens and of Westminster and Waterloo Bridges; but this is a matter which could afterwards be dealt with by the committees concerned. After full and careful consideration of the facts, and of estimates put before us by the Council's officers, we have come to the conclusion that it is desirable that the electric light should be adopted as the illuminant for the Victoria embankment, and that the Council should itself undertake the work in connection therewith. We accordingly recommend—

> "That, subject to an estimate being submitted to the Council by the Finance Committee as required by the statute, it be referred to the Highways Committee to carry out, at a cost not exceeding £10,000, an electric installation with the necessary plant for the lighting of the carriageway, footways, and parapet walls of the Victoria embankment."

Mr Grosvenor, on behalf of the Bridges Committee, appealed to the chairman of the Highways Committee to establish plant on such a scale as would permit of the bridges which abut on the embankment being also lighted by electricity.

Mr Benn, in reply, stated that if Mr. Grosvenor would bring forward an additional estimate of £2,500 or £3,000, the Highways Committee would be very glad to join hands with the Bridges Committee and light the bridges as well as the Embankment.

Mr. Beachcroft moved, and **Major Probyn** seconded, that the report be referred back for further consideration.

After some discussion the recommendation of the committee was agreed to with the following addition: "And that the Highways Committee do also confer with the Bridges Committee and Parks Committee respectively, and report whether the plant can be established on a sufficient scale to enable Westminster and Waterloo Bridges and the Embankment gardens to be lighted from the same source.

COMPANIES' MEETINGS.

WEST COAST OF AMERICA TELEGRAPH COMPANY.

The fifteenth ordinary general meeting of this Company was held last Monday at Winchester House, 50, Old Broad street, Mr. Henry Roberts presiding.

In moving the adoption of the report, the **Chairman** spoke in terms of regret of the death of the late chairman, Mr. Alfred Marshall. With reference to the report, their gross earnings, although showing a very large decrease as compared with those of the previous year, might be considered satisfactory when all the circumstances were taken into consideration. The year under review was ushered in with the revolution in Chili, which was not terminated until the end of August. The Company's cables were interfered with by both parties, but they were all repaired between April 17th and May 6th. Certain sections of their system were closed for public traffic by order of the Congressionalists and of the Balmaceda Government. The Company received some compensation for the suspension of their business until March 18th. With reference to the cutting of their cables they had preferred a claim for the expenses incurred in effecting the repairs, which had been charged to the revenue account. Their claim was now under the consideration of the Government of Chili. Negotiations with the Brazilian Submarine and the Western and Brazilian Telegraph Companies, conducted under the presidency of Sir John Pender, K.C.M.G., had been brought to a satisfactory termination, resulting in the formation of a new company. The share capital of the company, £100,000, would be held by the Brazilian telegraph companies and this Company. The line being worked for their joint benefit, and connecting, as it would do, the ports of Valparaiso and Buenos Ayres, would give them a connection with the Brazilian companies and the Eastern Telegraph Company over a line duplicated throughout, and opening up a rapid and efficient service between the west coast and Europe. The new land line was already in course of construction. The American Company, having acquired since January 1 last the existing land line between Valparaiso and Buenos Ayres, had so adjusted the tariffs as to exclude this Company from participating in any European traffic at their principal stations, and this state of things would continue until the new line was completed, when the public would have the benefit of a service which would carry messages between Europe and the west coast of South America entirely over lines owned by English companies and worked by English operators. As to their earnings during the present year, it had been thought desirable, owing to the competition, not to publish or issue in any form the monthly receipts.

The motion was seconded by **Mr. Frederick Walters**, and adopted.

Mr. J. Denison Pender was afterwards elected a director and the retiring members of the Board were reappointed.

NEW COMPANIES REGISTERED.

Electrical Coal Cutting Contract Corporation, Limited.—Registered by Lake and Co., 10, Lincoln's inn, W.C., with a capital of £402,000, divided into 60,000 £5 ordinary shares, 20,000 £5 deferred shares, and 2,000 £1 founders shares. Object: to adopt and carry into effect an agreement expressed to be made between the Woodfield Syndicate, Limited, of the one part, and this Company of the other part, for the acquisition of certain patents, particulars of which are given in the said agreement; and generally to carry on, in all their respective branches, the business of colliery proprietors, coke manufacturers, coal cutters, contractors, electricians, electrical engineers, mechanical engineers, producers, and suppliers of electricity, etc. The first subscribers are:

	Shares.
Sir A. C. Campbell, M.P., Blythswood, Renfrew	105
L. Wood, J.P., Hermitage, Chester le Street, Durham	105
Hon. G. W. Winn, Nostell Priory, Wakefield	10[illegible]
J. R. Knowles, Westwood, Ince, near Wigan	[illegible]
S. Rivington, Kilmeny, Wimbledon, Surrey	105
W. T. Goolden, 28, Westbourne park	105
F. Stobart, J.P., Biddick Hall, Fencehouses, Durham	10[illegible]

Each of the above signatories holds 100 ordinary and five founders' shares. There shall not be less than five nor more than 10 directors; the first to be elected by the signatories to the memorandum of association. Qualification, five founders' and 100 ordinary shares. Remuneration not specified.

Pacific and European Telegraph Company, Limited.—Registered by Bischam and Co., 30, Old Broad street, E.C., with a capital of £100,000 in £10 shares. Object: to adopt and carry into effect an agreement expressed to be made between the Brazilian Submarine, Western and Brazilian, the West Coast of America, and the Pacific and European Telegraph Companies of the one part, and Sir John Pender, K.C.M.G., of the other part, for the construction and maintenance of telegraphic communication between Buenos Ayres, Valparaiso, and Santiago. The first subscribers are:

	Shares.
Sir J. Pender, K.C.M.G., 18, Arlington street, S.W.	1
Sir J. Anderson, 62, Queen's gate, S.W.	1
T. Fuller, 18, Chesterfield street, W.	1
A. Wood, Abbey wood, Belvedere, Kent	1
Lord R. H. Brown, Reigate, Surrey	1
R. Collett, 50, Old Broad street, E.C.	1
R. M. Cunningham, 19, Great Winchester street, E.C.	1

There shall not be less than three nor more than five Directors, and each of the above mentioned first three companies is entitled to nominate one Director for each 2,300 shares of the original capital of the Company held by them respectively. Qualification, £100. Remuneration to be fixed by the Company in general meeting.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino Brazilian Company, were £2,792.

Eastern Extension Telegraph Company.—The Directors of this Company have declared an interim dividend for the quarter ended March 31 last of 2s. 6d. per share, tax free, payable on 1[illegible] prox.

Messrs. Arthur B. Gill and Co.—Mr. Arthur B. Gill, trading under the above title at 36, Parliament street, Westminster, has filed a deed of assignment for the benefit of his creditors: debts, £5,831; net assets, £4,084.

City and South London Railway.—The receipts for the week ending June 26th were £747, against £697 for the same period of last year, or an increase of £50. The total receipts to date from January 1, 1892, show an increase of £1,257 as compared with last year.

Chili Telephone Company, Limited.—The report of the Directors of this Company to March 31, 1892, states that the business of the Company during the past year has been less profitable than that of the two previous years. This unfavourable result is due solely to the political and other abnormal calamities which befell the Chilian nation and affected adversely the affairs of the Company. The income from subscriptions and other sources which in in 1890-1 was 387,110dol., has fallen for the year 1891-2 to 378,830dol. The lines have been gradually, steadily, and as promptly as possible restored, and the subscribers re-connected with the exchanges, so that the number of subscribers now served is nearly, if not quite, equal to what it was before the civil war began. As the bulk of the increased expenditure has been caused by the revolution, a claim has been made against the Government, of which 115,000dol. remains unpaid. No part of this sum has been treated as an asset in the Company's accounts; whatever may be hereafter received from the Chilian Government will be credited to future revenue. The balance of profit in sterling for the year was £6,067, which, with the balance brought from last year, viz., £14,209, makes £20,276 available for division. As the profits have been used for capital purposes, they cannot be divided in cash, but the Directors recommend that deferred warrants be issued for 10 per cent. on the share capital, and that these warrants, at the option of the holders thereof, be accepted by the Company for ordinary shares, which will carry dividend from April 1, 1892.

Antidote to Mercury.—M. Friquet, who is engaged in the manufacture of lamps at Paris, states that iodide of potassium is an efficacious antidote to the trouble with mercury fumes sometimes experienced in the incandescent lamp pump-room. A daily dose of a quarter of a gramme in 400 cubic centimetres of milk is recommended.

Telephones for Vyrnwy.—The Liverpool City Council on Wednesday authorised the Water Committee to arrange by contract or otherwise for the requisite telephonic communication and other electrical appliances required between Liverpool and Lake Vyrnwy and between Liverpool and Rivington reservoirs, at a cost of not exceeding £4,000.

Brazil Telephones.—Telephonic communication will shortly be established, says the *Financial News*, between Rosario and Buenos Ayres, the installation costing about 300,000dols. gold. The lines will pass through Belgrano, San Isidore, San Fernando, Tigre, Baradero, San Pedro, San Nicholas, and will belong to a French company, who will use the Testu system.

Hammersmith.—A committee of the Hammersmith Vestry is to take under immediate consideration the desirability of applying for a provisional order for electric lighting, and taking the necessary steps for obtaining parliamentary powers to supply electricity for public and private lighting, with a report on the cost and the most convenient areas to be lighted.

Chelmsford.—At the last meeting of the Town Council, communications were read from the Board of Trade stating that they had given Messrs. Crompton and Co.'s agents notice of certain alterations which were necessary in the electric lighting arrangements at Chelmsford, and giving them two years in which to comply with the notice. The matter was referred to the Lighting Committee.

Awards. — The French Société d'Encouragement, besides the prize of 3,000f. to M. Hillairet, have awarded a gold medal to M. Hermite for his electric bleaching process; a platinum medal to M. Marès for his electric meter; a bronze medal to M. Legoaziou for his electric scrutator; and a commemorative medal to M. Hippolyte Fontaine for his paper on industrial applications of electricity.

St. Helens.—At the St. Helens Town Council on Wednesday, Councillor Leach asked the Parliamentary Committee to obtain a better service of trains between Liverpool and St. Helens, and also urged the importance of an omnibus service. This is the sort of opportunity which would be at once taken in America to run an electric street railway with an abundant and quick service.

City Electric Light Standards.—At the Commissioners of Sewers last week, Mr. G. Harris was anxious to know why some of the new electric light standards were of one shape and some of another. The City engineer replied that in the crowded thoroughfares it was thought better to have the round standards to economise space, but in other streets they had the full size square standards.

Incandescent Lamps.—The Cheesbrough flashing patents run out in October. We are to expect lamps at two shillings, or less, burning at 1½ watts per candle power for 400 hours after that date, so we are told. The 1½ watts efficiency would make it good for supply companies and customers alike, for the one could supply more customers, and the other would pay less for current. The "400 hours" is still problematical.

Postal Telegraphs.—According to a return of the revenue and expenditure of the Post Office Telegraphs for each year since the purchase, we notice that the estimate of the figures for 1891-2 show a total revenue return of £2,542,200, the estimated expenditure being £2,633,050. This shows a net revenue deficit of £90,850. To this should be added the interest on stock created for the purpose of telegraphs, which comes to £299,052.

Huddersfield.—The Gas Committee at the last meeting of the Huddersfield County Council reported that the Local Government Board had given their sanction to the borrowing of £50,000 for the purposes of electric lighting, £12,000 being for the necessary buildings, to be repaid within 30 years, and £38,000 for the general purposes of electric lighting, to be repaid within 15 years. The contract has been secured, it will be remembered, by the Brush Company.

Isle of Man Exhibition.—The Isle of Man Exhibition of Manufactures, Science, and Art was opened on Wednesday by the lieutenant-governor, Mr. Spencer Walpole. The exhibition is situated at the Bellevue Gardens, about a mile from Douglas. The buildings cover 100,000 square yards. One of the most prominent features of the exhibition is the model of the "Victory," which was exhibited at the London Naval Exhibition. The exhibition is lighted by electric light by the Brush Company.

Glasgow.—Tenders are required by the Glasgow Gas Committee for providing and erecting (1) steam engine and pipes; (2) dynamos, switchboards, and connections, and (3) arc lamps. Plans and specifications may be seen, and forms of tender obtained, on application to Prof. Kennedy, 19, Little Queen-street, Westminster, consulting engineer to the Corporation, or to the Gas Office, Glasgow. The various tenders will be received by Mr. J. D. Marwick, town clerk, City Chambers, George-street, Glasgow, on or before 12th inst.

Lacombe Carbons.—A new company, entitled "Le Carbone," have acquired the well-known carbon business of Messrs. Lacombe and Co., of Levallois-Perret, near Paris, and will continue the manufacture of carbons for electrical applications of every description. The plant will be extended, and the entire staff, as well as the services of M. Lacombe himself, have been retained by the company. The managing director is M. M. Blair. The London branch will remain under the management of Mr. J. O. Williamson.

The Lane Fox Case.—The appeal case of Lane Fox v. Kensington and Knightsbridge Electric Lighting Company has been heard and finished, the decision being held over. This case has instituted an interesting precedent, as the defendants' counsel, after full *viva voce* argument, put in a written summary of the points on which they relied. Thereupon Mr. Lane Fox was allowed to prepare and hand in a written statement of his own case. This concession involves a return to very early practice in pleading of the English Bar, and is likely to prove of great assistance in technical cases.

Punkahs. — Messrs. Jessop and Co., Limited, of Calcutta, have recently put down a whole installation of compressed air punkah-pullers in the Dalhousie Barracks, Fort William, including a 14 h.p. steam engine. Ten motors drive 619 punkahs. It would be thought that electric motors and fans would be equally or better suited for such a function, and if a 14-h.p. steam engine is worth putting down here, other large installations will be wanted. In India, coolness as well as light are required, and a large number of Government buildings are open for application. A little enterprise might result in good orders.

The General Election.—Electric light has played its part in the general election contest that has been upsetting both business and amusement during the past week. At the National Liberal Club, Messrs. New and Mayne, electrical engineers, of 12, Palace-chambers, Westminster, had

arranged a large board hung out from the tower fitted with incandescent lamps, and on these the results were flashed out in large capital letters and figures 4ft. high. A light at the top showed gains and a light at the bottom losses. The results were thus flashed out and could be seen and read by everyone far down on both sides of the river.

Electric Motor Controller.—The Thomson-Houston Company have long been experimenting with the idea of getting better control of tramway motors than the usual resistance. They have now brought out a controller with which they seem satisfied from the practical side, consisting of connecting switches for altering the connections of two-car motors from series into parallel, so that for slow speed the two motors will be in series, giving in consequence a high counter E.M.F. (that of each motor being in series with that of the other) at a low rate of speed, while for higher speeds they are connected in parallel. The Thomson-Houston Company claim to hold controlling patents for this class of apparatus, the most important being United States patents 385,055, June 26, 1888; and 393,322, November 20, 1888.

Small Alternate-Current Motors.—We hear that Messrs. Shippey Bros., the firm who have been well known as pioneers for the Crocker-Wheeler continuous-current motors in this country, are in the market with a new small alternate-current motor, $\frac{1}{8}$ h.p. and above, wound for 100 to 110 volts, a number of which have been already supplied and are working on the London Electric and City circuits, driving ventilating fans, sewing machines, and so forth. Messrs. Shippey Bros. are reticent at present respecting the details of the motors, but we learn that motors are being tested by several well-known electrical engineers. Alternate-current companies will await with interest the result of the experiments, which, if satisfactory, opens the field of profit for the use of current during the day.

Water Power in Sweden.—Mr. H. Aulin, of Norrköping, Sweden, advertises in the *Times* as for sale, in the centre of Sweden, a waterfall of about 3,000 h.p., in the Dalelven. This, he says, is very suitable under the most economical conditions for all industrial undertakings, such as installation of very powerful electrical generators. Situated near the Avesta railway station, in the south of the Dalarne province, in an important mining and industrial centre, it has communication with all the railway lines and ports of the country. The waterfall, dam, surrounding land, with 20 hectares agricultural land, 18 hectares prairie, forest of fir trees (85 hectares), necessary buildings, as well as flour mill and salmon fishery, are included in the sale. Here is a fine chance for some enterprising electrical engineer with financial backing — almost as good as Niagara, according to the advertisement.

Sulphur.—Herr Grop, of Berlin, has communicated to the Physical Society of that city, we read, some exceedingly interesting results of a series of experiments he has undertaken upon the composition of sulphur. He melted sulphates of barytes and of strontian in a crucible of silver, which served as one electrode, the second electrode being formed of a platinum wire dipping into the melted mass. After the passage of a strong current of electricity for a certain time, the experimenter proceeded to analyse the resultant mass. He found that the barium had combined with the platinum to form a compound unknown up to the present time, and stated at the same time that about 50 per cent. of the sulphur had disappeared to make place for 40 per cent. of still another entirely new compound. Herr Grop considers that he has proved that sulphur is not an element, but a compound of the new substance and hydrogen.

Cost of Club Lighting.—The London clubs have long felt the benefit of the electric light, but are now feeling the charges too much for their purses. A meeting of the secretaries of some of the principal clubs was held the other day at White's Club to discuss the question of the charges made by the electric lighting companies for supply of current. The following clubs were represented, all of which use the electric light: White's, Devonshire, Travellers', Windham, Reform, Orleans, St. Stephen's, Conservative, Brooks's, Junior Army and Navy, Thatched House, National, Oxford and Cambridge, and Prince's. A deputation from the meeting was appointed to wait upon the directors of the companies supplying these clubs, to request that a considerable reduction should be made in the charges, which, it was agreed unanimously, had become too onerous. The question is, of course, a purely business one between buyers and sellers.

Tivoli Transmission.—The Rome correspondent of the *Daily News* telegraphs on Wednesday: "At Tivoli yesterday were inaugurated, in the presence of the Minister of Posts and Telegraphs and a great many scientific men, the works for the electric lighting of Rome. A volume of 141 cubic feet of water, having a fall of about 164ft., is distributed between six turbines furnishing over 2,000 h.p. Besides these, three other turbines, each of 50 h.p., are destined for the dynamos. From Tivoli the electricity is brought by means of four copper wires in suspension over 712 steel standards to Rome, a distance of about 22 miles. The total loss of power is 20 per cent. A Budapest firm has furnished most of the machinery, and Austrian electricians have co-operated with Italian savants in solving the technical problems of the installation. Letters of congratulation from Prof. Silvanus Thompson and Messrs. Fleming and Preece, among others, were read at the ceremony yesterday."

Alternating and Continuous Currents.—The two rival factions of alternate and continuous-current advocates are possibly a little nearer amalgamation than they expected, if we are to believe the news which comes to us from an authentic source, with reference to an interesting series of experiments in France. Amongst those who are pushing forward the possibilities of the application of alternate currents in that country stand prominently Messrs. Hutin and Leblanc, whose experiments on motors and transformers we have followed from time to time in these columns. These gentlemen have recently been experimenting with condensers, a field of which great things may be expected shortly both in the application of alternate current to motors, and to the rectification into direct currents. We understand that experiments have been carried out showing that secondary cells can be charged by these rectified alternate currents at an efficiency for the current of 96 per cent. This result promises large things for alternate-current engineers.

Claybury Asylum.—Tenders are invited for generating plant and mains required for the installation of electric light at the London County Lunatic Asylum, Claybury (Woodford) Essex, for the Asylums Committee of the London County Council. Printed forms of tender, contract (with specification and schedules annexed) and bond, and lithographed copies of the drawings, can be obtained on application to the clerk, at the offices of the committee, 40, Craven-street, Strand, on payment of £5, which will be returned on a bona fide tender being delivered within the appointed time, or on return of the forms and drawings before that time. Schedules of prices and of rates of wages and hours of labour, etc., are to be attached fully priced out and

signed. The tenders are to be delivered at the offices of the London County Council by noon on July 26. The contractor will have to enter into a bond in £500 with two approved sureties in £250 each as security. Application to be made to Mr. R. W. Partridge, clerk to the Asylums Committee.

New Brush Dynamo.—The following particulars are given in the New York *Electrical Engineer* of the Brush Electric Company's new dynamo and motor: They have been designed by Mr. S. H. Short, chief electrician to the company, and the generator takes 100 h.p. on the pulley. The armature is of the closed coil type, with core of thin sheet iron riveted on a foundation ring, the edges of this ring being milled to allow for bobbins. The wires leading from the armature to the commutator are carried along the shaft, and are carefully covered to protect from dirt or damage. The bearing on the commutator side is placed outside the commutator to allow a clear way for connections. The generators are compactly built, and the ventilation is perfect. Any part can be inspected without disarranging other parts, and in case of accident armature or magnets can be easily removed for repair. The motor of this type requires no outside governor, being perfectly automatic in action. They are wound for 1,000 volts for transmission of power over small wires. The new type of commutator, with which both generator and motor are fitted, runs practically with no sparking.

Handsworth.—At the meeting of the Handsworth Local Board on Wednesday Mr. J. J. Hughes presented the Highway Committee's report, which recommended the Board to sanction the present steam arrangements on the South Staffordshire Tramways Company's cars for a period of six months, to be extended for a further period of six months on the company undertaking to adopt an approved system of electric or cable motive power. The committee also recommended the Board to consent to the use of steam by the Central Tramways Company on their Birchfield and Lozells route for 12 months. Mr. Henry Hossell, in seconding the adoption of the report, said he hoped it would be the last time he would be asked to give his consent to the use of steam. The ratepayers were very much annoyed at the abominable nuisances which existed, and if the Board did not take some sort of action they would take action themselves. He had no hesitation in saying the property in the Birchfield road had depreciated to the extent of £10,000, and houses in that neighbourhood were now let at £10 which formerly used to realise £60 per annum. The report was adopted.

Catalogue.—We are in receipt of the catalogue of the Newton Electrical Engineering Works, Taunton. This company make a speciality of their "Taunton" dynamos, which we have several times noticed. These are of an inverted two-pole type and of good design. The catalogue shows a combined Priestman oil engine and "Taunton" dynamo—a useful combination for country house. This company have some useful specialities in the way of adjustable brushholders, in which by means of a milled screw the brushes can be accurately adjusted during running. Their automatic charging cut-out is a neat and useful piece of apparatus, and the "Newton" arc lamp is very simple and cheap. A quite novel piece of apparatus is a swinging switchboard for use in central stations or other installations. The wires come up a central hollow standard, and are arranged with slack wire so that they permit the switchboard itself to be swung forward on its hinges when required for inspection or alteration of connection. The swinging switchboard can be locked into place when all is fixed, and it is claimed the advantage in case of handling more than compensate for the slight extra cost. The company also make their own alternate-current transformers.

New Street in London.—Sardinia-street central station is apparently threatened with extinction by the new and comprehensive scheme for a new broadway between Holborn and the Strand, brought in by the Improvements Committee of the London County Council. This, however, may be a mistake or misreading of their project, and perhaps the station can be arranged to be left; but the idea seems to be to form a new and broad street from Little Queen-street and Holborn to St. Mary's Church in the Strand, to remove the Holywell block entirely, and on the northern side, where the new street will come out, to form a double sweep in a curve round the church, thus forming a magnificent chance for architectural decoration. The new street is to be 100ft. broad, and at the middle, it is stated, on the present site of Sardinia-street, a circus will be formed, obliterating the whole of the present district. The scheme will cost £2,000,000, and will certainly greatly improve the metropolis. The chance should be taken to put in electric wire subways, so that in one street at least we may be saved the trouble of constantly opening the roadway and pavements. The street will naturally be fully lighted with arc lamps. It is suggested to call it "Council broadway."

University College.—The Council of University College, London, have been desirous for some time past of extending and improving the provision made in the college for teaching the important practical sciences of mechanical and electrical engineering. University College, London, was the first college in the United Kingdom to establish a system of scientific laboratory instruction in mechanical engineering. In that laboratory methods of teaching were introduced by Prof. Kennedy which have been since extensively followed in other similar institutions, and the engineering laboratory so established in University College, London, has proved a model for larger and better equipped laboratories which have been founded in other colleges. Owing, however, to the rapid advances in mechanical, and especially in electrical engineering, the present provision for teaching those subjects is no longer adequate. The council have accordingly commenced to build more commodious laboratories and lecture rooms for teaching mechanical and electrical technology. These laboratories, when completed, will, says Prof. Fleming (writing to the *Daily News* of Wednesday), offer greatly increased facilities for teaching these applied sciences. The council do not at present see their way to incur the additional expenditure necessitated by these improvements. It is estimated that a sum of at least £2,000 will be required to fit up properly that part of the laboratories to be devoted to electric engineering, and subscriptions are invited from the friends and old students of University College, to be sent to the Secretary of University College, marked "Electrical Apparatus Fund."

The Conversazione.—The President of the Institution of Electrical Engineers (Prof. W. E. Ayrton, F.R.S.) and Mrs. Ayrton received a brilliant assembly to their *conversazione* on Friday last. From 9 o'clock till midnight the beautiful rooms of the Royal Institute of Painters in Water Colours were crowded, at one time almost inconveniently crowded, so great was the popularity amongst electrical and scientific celebrities of Prof. Ayrton's reception. Amongst the numerous assemblage of visitors and members present we may mention: Prof. W. Grylls Adams, F.R.S., Sir James Anderson, Sir Benjamin Baker, K.C.M.G., Mr. C. Vernon Boys, F.R.S., Mr. A. R. Bennett, Mr. R. E. Crompton, Prof. W. Crookes, F.R.S., Captain Creak, R.N., F.R.S., Prof. Crocker and Mr. W. J. Hammer, (both vice-presidents of American I.E.E.), Sir

H. Doulton, Mr. H. W. Christmas (Servian Consul-General), Prof. Carus Wilson, M.A., the Rev. J. R. Diggle, Prof. G. Forbes, F.R.S., Mr. S. Z. de Ferranti, Mr. Desmond FitzGerald, Mr. E. Graves, Sir Douglas Galton, K.C.B., Dr. E. Frankland, F.R.S., Prof. G. Carey Foster, F.R.S., Major-General Festing, F.R.S., Dr. J. H. Gladstone, F.R.S., Prof. D. E. Hughes, F.R.S., Colonel R. Raynsford Jackson, Dr. J. Hopkinson, F.R.S., Dr. E. Hopkinson, M.A., Lord Kelvin, P.R.S., Prof. Oliver Lodge, Mr. W. H. Preece, F.R.S., Sir Henry Mance, C.I.E., Prof. R. Meldola, F.R.S., Mr. E. Macrory, Q.C., Dr. Ludwig Mond, F.C.S., Dr. Hugo Miller, F.R.S., Mr. Gisbert Kapp, Major Flood Page, Prof. A. B. W. Kennedy, F.R.S., Prof. J. Perry, F.R.S., Mr. J. W. Swan, M.A., Sir D. Salomons, Bart., Mr. C. E. Spagnoletti, Mr. A. Stroh, Earl Russell, Prof. S. P. Thompson, F.R.S., Mr. Edward Woods, Mr. R. W. Wallace, Prof. W. Ramsay, F.R.S., Dr. John Rae, F.R.S., Mr. G. J. Symons, F.R.S., and many others. During the reception, while visitors were inspecting the lovely portraits on the walls, or exchanging greetings, the band of the Royal Horse Guards Blue were down to play a fine programme of music. A rather unique ending was given to this meeting by the energies of Mrs. Ayrton and her friends, who just before midnight arranged an impromptu carpet dance, bringing to a merry finish a most enjoyable social evening.

High-Tension Transformers. — Experiments in high-tension work have been carried out hitherto almost exclusively by German, English, and American engineers. France is now taking her part in this field of work, and a series of high-tension transformers have been recently constructed for MM. Hutin and Leblanc, to be used at the Société de la Transmission by M. Labour, engineer to the Société L'Eclairage Electrique. The experiments of MM. Hutin and Leblanc have necessitated the construction of transformers of special output. One of these is for a capacity of 6,000 watts, transforming from 150 up to 10,000 volts, with an efficiency of 94 per cent. at a frequency of 80; this transformer can be run up to 30,000 volts without difficulty. Two other transformers, of 15,000 watts capacity, transform from 25 volts up to 10,000 volts, with an efficiency of 88 per cent. at the minimum, at a frequency of nine, and by increasing the frequency the pressure can be run up without inconvenience to 36,000 volts. Special precautions have been taken to guard against faults. The primary and secondary circuits are entirely separated from each other, and immersed, for one of the transformers, in paraffin, and in the two others in oil arranged to circulate freely. It is interesting to note that the length of one of the primary circuits is 14 kilometres (about 8½ miles). These transformers are constructed for the system of double transformation, transforming both at the generator and at the receiver. This system is now acknowledged have considerable advantages over the direct method for high-tension work. The low-tension dynamos are less expensive, more efficient, and much easier to manage. The danger to the attendants is less, and the material used is cheaper. The efficiency of the transformers is taken in the following manner: The average output of the transformers was raised to 4,000 watts at 25,000 volts, and with a frequency of 43. Two transformers were coupled together for double transformation. The thick wire of the first was connected to a low-tension dynamo, and of the second to a set of variable resistances without self induction, and the two fine-wire circuits, at 25,000 volts, were connected together. The energy given at the terminals of the low-tension circuit of the first transformer and that received at the non-inductive resistances of the second was measured by ampere-meter and voltmeter. It was found that the efficiency of each transformer was 94 per cent. at half load. It must be noticed that this supposes the apparent self-induction of the transformers themselves to be nil, and the real efficiency is therefore rather higher than that found. These transformers are the first of their kind built in France, and the result of the experiments has given great satisfaction to the designers and manufacturers.

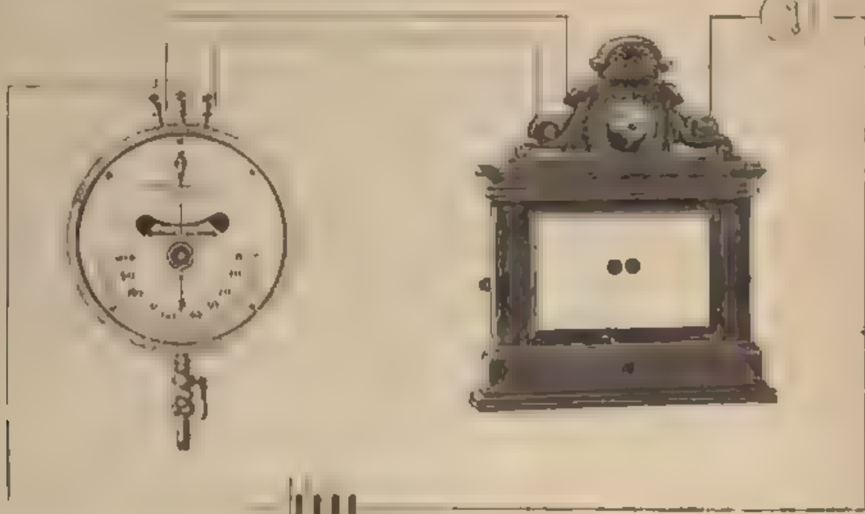
Bruce War Balloon.—An ascent of the Bruce electrical war balloon was made on Thursday night in the Stamford Bridge Grounds, Fulham-road, under the personal superintendence of the inventor, Mr. Eric Bruce, M.A., F.R.Met.S., to demonstrate the utility of the balloon for flashing signals by night. This method of signalling was first exhibited at the Inventions Exhibition of 18.5, and while on exhibition the system was referred for Government trial by the Royal Engineers at Chatham, and the result was that orders were shortly after received from the War Office. A second trial, undertaken in a snowstorm, was equally successful, and the Belgian and Roumanian Governments investigated the invention. The object of the invention, as its name implies, is to facilitate night signalling to long distances and in places where ordinary signalling would be impracticable, such as in wooded and hilly districts. With the help of a translucent balloon lighted interiorly, a mountain between two friendly parties would place no barrier to inter-communication. The apparatus is simple and portable, consisting of a balloon made of a material that is perfectly translucent, with several incandescent lamps, supported on a specially devised holder, placed inside. The lamps are connected with batteries on the ground. In the circuit is an apparatus for making or breaking contact rapidly, and by varying the duration of the flashes of light it is, of course, possible to signal according to the Morse or any other code. Various improvements in detail have been made, and the demonstration was to show the practicability of the invention for war purposes. The balloon used is 18ft. in diameter, made of extremely translucent material. Six 16-c.p. lamps are placed inside, taking a total of nine amperes at 24 volts. The battery used is 26 E.P.S. cells of E 7 type. The improvements mainly consist in the reduction of weight in almost every portion of the apparatus, so as to increase its portability and efficiency. The balloon itself is made of a much lighter material than those first exhibited, while the weight of the ladder-shaped holder inside the balloon is reduced to a minimum. Each of the storage cells now only weigh 24lb. An improved signalling key is used, having carbon contacts; these can easily be renewed at trifling cost when worn away by the sparking. The system of signalling by the translucent balloon is supplemented by an arrangement for flashing lamps outside the balloon, as this plan is thought to be better adapted for certain conditions of atmosphere, when penetration is desirable. It has, however, been found in practice that the system of flashing lights inside the balloon has, in clear weather, great advantage over outside open lights, as it produces flashes that are sharp and distinct, whereas signalling with open incandescent lamps is apt to produce indistinctness, owing to the fact that incandescent lamps do not cease to glow instantaneously when the current is interrupted. The balloon is also useful for navy and coastguard signalling. The experiments shown consisted of ascent of pilot balloons and of the large translucent balloon; exhibition of system of flashing signals by lamps inside balloon; continuous illumination of balloon for use as fixed point; moving the lighted balloon a short distance above the ground as a light for working parties; flashing of open lights outside balloon; finishing by flashing "God save the Queen" in Morse code.

THE CRYSTAL PALACE EXHIBITION.

Continuing the description given on June 24 of the exhibit of American electrical specialities by **Mr W. J Hammer,** we give some account of two important exhibits in the shape of the Ward arc lamp, and the automatic recording instruments of the Telemeter Company

Ward Arc Lamp. -The action of this lamp has been much admired at the Crystal Palace. It gives a remarkably steady light, and its action at cutting in seems simply perfect. The arc strikes at once without the slightest difficulty, and starts right off, without flickering or jumping, at full brilliancy. The Ward arc lamp is manufactured by the Electric Construction and Supply Company, of New York, and, we are given to understand, is taking, or has taken, precedence in America over almost every other form of arc lamp. To give some idea of the use of these arc lamps in New York and suburbs, it is sufficient to mention that the Edison Company of New York and the Edison Company of Brooklyn have each central stations of a capacity of 130,000 16 c p. lamps, and both of these stations have over 1,100 Ward arc lamps running on their incandescent circuits, and are increasing the number at the rate of 100 a month in each. The special type of lamp here alluded to is the continuous current lamp for running on incandescent lamp circuits—a type that is now most in demand. The Ward Company manufacture no less than 43 different types of arc lamps, both for series and parallel running, and for alternating and continuous currents, but the lamps shown at the Crystal Palace are of the type that is meeting with the most extensive sale—to run two in series on a 100 110 volt circuit. The lamp is very simple in construction, with gravity feed, and although great sensitiveness is claimed for its action, it will burn satisfactorily a cheaper kind of carbon than most lamps in the market. Experiments which we witnessed showed the lamp can be cut in and out any number of times in succession, the arc starting instantly, while not the slightest flicker in burning is perceptible.

The Telemeter Company, of New York, exhibit a set of their indicating and recording instruments, which are the result of 14 years' experiment in simplifying and perfecting electrical recording apparatus. Over £20,000 have been spent in perfecting these instruments, and many valuable ideas have been embodied covered by patents held by the Telemeter Company. The various instruments are shown at the Crystal Palace in practical operation, in recording the pressure of the boilers, temperature of the rooms, pressure on the water system, the electric mains, and so forth We see telebarometers, telethermometers, telemanometers, and other telemeter instruments for indicating and recording steam, water, gas, and other pressures, of levels of water, oils, or other liquids in reservoirs, standpipes, the movements of gasometers, temperatures of fluids, gases, etc., or vulcanising or welding furnaces, drying-rooms, and breweries. Many of these instruments are in use in America, employed by various prominent companies, municipal corporations, and others. Automatic recording and electrical instruments are shown at work on the same plan, for registering at a distance. These instruments are fitted with an adjustable alarm contact, for high and low points, to ring a bell at any desired place. The exhibit forms a very valuable collection of recording instruments, such as are likely to prove a great aid in many departments of business.



Telemeter Instrument for Indicating Pressure at a Distance.

Cables and Wires.

If one could only see and realise the fact, perhaps the most important and largest article in use at the Electrical Exhibition is not the machinery, the lamps, or the fittings, but the wire. In the shape of cable large and small, bare and covered; of copper conductors—strip and wire, of flexibles—telegraph, telephones, electric light, submarine cables, bells, heaters, and power transmission—all these require one important factor summed up in the word "conductors." The total length of wire used in the Crystal Palace Exhibition must figure as something almost appalling. Unfortunately, from the exhibitor's point of view, most of it is out of sight, silent, unmoving, unappealing to the general inquisitiveness. There is a strange fascination to the human mind in seeing anything in action, it appeals to the "time factor" of the brain, as one might say, and even those who are best instructed and know exactly what to go to and what to look for, are always arrested by a movement or an unusual noise in an exhibition. It is for this reason that moving machinery and processes in action always prove the most attractive part of exhibitions But the wire—the mere "electric piping," useful, though humble, servant of the dynamo and the lamp—how can this be expected to catch the attention of any but the specialist? Nevertheless, the great firms—Henley's, Glover's, Silvertown, Siemens, Johnson and Phillips, Helsby—all wish their names brought prominently before the world in connection therewith, for who knows in this age of electricity what orders for thousands of pounds worth of goods may not be going at any moment.

The question might indeed very well be asked, Which is the best way to exhibit cables and wires? Sections of cables and coils of wire are very good in their way, especially if made up into handsome trophies. But could we not see sets of samples in process of manufacture, from the commencement, action by action, layer by layer, to the finish? Then, again, conductors are made to conduct, to carry electrical energy. Could we not see them as conductors, endowed with strange properties, instead of inert masses of rubber and copper? It might be an idea worth having. Wires with waxing and waning currents passing would be easy to arrange, and the effects on magnetic needles or by electromagnets would be noticeable, large solenoids, with suspended floating iron cores and other devices, might, indeed, savour of lecture tricks, but would

certainly prove interesting to any visitor; while an organised set of scientific experiments and tests, on insulation resistance, electrostatic capacity, sparking distances for high voltage, specification of tests to be stood by electric light cables, and so forth, should give, by the emulation of the manufacturers, valuable results to the scientific and practical world.

But we must put aside such matters for the present. The Crystal Palace Electrical Exhibition of 1892 has come and gone, leaving many problems raised and discussed, and a better knowledge given to the public of the immense strides of progress made since 1881. If in any particular branch there is not so much progress necessary, it is in the manufacture of electric cables, which already by the needs of telegraphic work in early years had then reached a very high point of perfection. The adaptation of telegraphic cables to electric light requirements was effected without much difficulty. The adaptation of insulated cables to withstand the enormous electrical pressures of 2,000, 10,000, or even 50,000 volts, was far more difficult, but it has been done, and the future may see these latter degrees of pressure no more thought of than 150lb. or 200lb. pressure of steam is now. For this we have to thank both the progressive nature of a few enthusiastic electrical engineers, and the able work done by the manufacturers, who, ever ready to adapt themselves to the growing needs of the industry, have spared no pains to fulfil the demands upon their skill.

Among the foremost of the great cable and wire manufacturers we have to mention **W. T. Henley's Telegraph Works Company, Limited,** of Martin's-lane, Cannon-street, and North Woolwich. This company have been widely occupied in cable manufacture ever since the foundation of the works by Mr. Henley in 1853, since which time over 15,000 miles of submarine cable have been made by them. At the time of the great development of the electric light industry in 1881, they introduced the patent ozokerited indiarubber cores and the vulcanised rubber insulation, and from that period onward have followed the increasing activity in telephone, electric light, and transmission work, producing all kinds of insulated wire and cable, up to the most recent requirements, among which we should mention the underground electric light cables for the Glasgow Corporation. These cables are of very large size, the case being half square inch section; the weight of the conductor is five tons to the mile, and the insulation 1¾ tons—being a total weight of 6¾ tons to the mile. The exhibit of the Henley's Company at the Crystal Palace contains some large plates of electrolytic copper of a minimum conductivity of 100 per cent. of Matthiesen's standard, being samples of the copper used in the electric wires and cables produced by the company. We see samples of the raw Para rubber as imported, many of the pieces being sent in amusingly grotesque shapes, as of ducks, bags, and various ornaments; then the pure rubber sheets and strips for insulating, and braided and hemp-covered cables. Sections of their submarine cables are shown, both deep-sea and shore-end; we see electric light cables for high and low tension work, arc and incandescent; telephone cables with separately insulated wires, and a large variety of smaller wires for different purposes. Round the stand are some extremely interesting photographs showing their cable ship "Westmeath"—being loaded with cable on its way abroad, during the process of laying and testing, with views of the machinery for paying out and buoying; and also some of the telegraph huts and shore ends for the submarine cables laid by the Henley Company. We also notice a case of the "Block" dry cell; a solid dry cell arranged in strong oaken case for hard work, forming a solid block. Their exhibit, though not large, is most important and suggestive, and the references to the large amount of work carried out in all parts of the world fully illustrates the position of the company in cable manufacture.

Another very noticeable exhibit of electric wires and cables is that of the well-known firm of **Walter T. Glover and Co.,** of 39, Victoria-street, Westminster, and Salford, Manchester. They have a very handsome exhibit, comprising practically every variety of electric light and telephone cable and wire that is in use at the present time. Cables for electric light and power naturally occupy the chief place, and the various qualities of insulation are represented by coils and sections. A specially fine show is made of flexible wires for indoor use—for telephones, pendants, movable electric standards, connection of instruments and dynamos, flexible cables, and so forth. Another speciality is the patent flexible metallic tubing applied to electric wires and cables. This flexible tubing consists of overlapping steel corrugated rings, tightly fitted in such a way as to afford perfect protection from ordinary injury and yet to be quite as flexible as ordinary stranded cable. A fine show is made with anti-induction telephone wire cables, to which special attention has long been paid by Messrs. Glover, and cables wrapped with foil round each wire to prevent induction are shown in different varieties. An exhibit is made of the hard drawn copper produced by Messrs. F. Smith and Co., of Halifax, used by Glovers for the cores of their cables and wires; and an interesting set of samples of wire gauge for different purposes is also shown. An exhibit of special interest to dynamo makers is the Compactum insulated copper strip or wire, very firmly and thinly, but well, insulated with varnished serving, ready wound on 2cwt. and 4cwt. drums for use in winding armatures. The amount of patient ingenuity and skill in adaptation of material to requirements needed for all the varieties of insulated conductors shown on their stand can hardly be indicated to the general public by the various sections and samples, but the technical man will have inspected them with great interest and appreciation.

Behind Messrs. Glover's stand we see a full-sized set of the **Johnstone Electric Subway Company's** patent conduits. We have already given, in our articles upon underground mains, full particulars, with illustrations, of this interesting system, of which it is proper to say it provides in a simple and easy manner for laying electric wires of all kinds in cast-iron troughs, and allows for connection and inspection with the least derangement of the conduit. Some hundreds of miles of conductors have been laid on this system in New York and other American towns, and its introduction is under contemplation in certain towns in England.

JURORS AND AWARDS.

The following is a list of the jurors and the awards made:

JURORS.

Prof. W. Grylls Adams, D.Sc., F.R.S.
Mr. L. Atkinson.
Prof. W. E. Ayrton, F.R.S.
Mr. Shelford Bidwell, M.A., F.R.S.
Mr. Conrad W. Cooke, M.I.E.E.
Prof. W. Crookes, F.R.S.
Mr. W. B. Esson, M.I.E.E.
Prof. George Forbes, M.A., F.R.S.
Major-General Festing, R.E., F.R.S.
Capt. Sir Douglas Galton, K.C.B., F.R.S.
Dr. J. H. Gladstone, F.R.S.
Mr. J. H. Greathead, M.I.C.E.,
Mr. Chas. Hall, M.I.E.E.
Prof. D. E. Hughes, F.R.S.
Sir Hy. C. Mance, C.I.E.
Mr. W. H. Massey, M.I.C.E.
Prof. J. Perry, F.R.S.
Mr. W. H. Preece, F.R.S.
Mr. A. Rechenzaun
Prof. Hy. Robinson, M.I.C.E.
Capt. Sankey, R.E., M.I.E.E.
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Mr. W. E. Sumpner, D.Sc.
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Major-General Webber, C.B., R.E.
Mr. J. W. Wilson, M.I.C.E.

AWARDS.

Diploma of Honour.

H.M. Post Office.
L.B. and S.C. Railway Company.
L.C. and D. Railway Company.
L. and N.W. Railway Company.
National Telephone Company.
Exchange Telegraph Company.
Crowley Bros.
Swinburne, J., and Co.
Willans and Robinson.

Diploma of Honour and Gold Medal (Highest Award).

Brush Electrical Engineering Company.
Edison and Swan Electric Light Company.
Crompton and Co.
Johnson and Phillips.
Siemens Bros. and Co.

Gold Medal.

Coxeter and Son.
Davey, Paxman, and Co.
Easton and Anderson.
Electric Construction Corporation.
Electrical Power Storage Co.
Glover, W. T., and Co.
Henley's, W. T., Telegraphic Works Company.
Laing, Wharton, and Down Construction Syndicate.
Nalder Bros. and Co.
Saxby and Farmer.
White, J.

Silver Medal.

Acme Electric Company.
Anderson, R., and Co.
Andrew, J. E. H.
Andrews, J. D. F., and Co.
Armstrong's Glass Company.
Barclay and Son.
Benham and Froud.
Bristol, L.
Britannia Rubber and Kamptulicon Company.
British Gas Engine Company.
British Stone and Marble Company.
Browett, Lindley, and Co.
Campbell Gas Engine Company
Chubb and Son
Consolidated Telephone Company
Davis and Timmins.
Day and Co. (Bath).
Dent and Co.
Dick, Kerr, and Co.
Edison Manufacturing Company
Epstein Accumulator Company.
Ferranti, Limited.
Fielding and Platt.
Fowler Waring Cable Company.
General Electric Company.
Giles, F., and Co.
Grover, W.
Groth, L. A.
Gulcher Electric Light and Power Company
Hammer, W. J.
Joel, H. F., and Co.
Laing, Wharton, and Down.
Lloyd and Lloyd
London Metallurgical Company.
Mosses and Mitchell
Osler and Co
Rashleigh Phipps and Dawson.
Richard Freres.
Richards, F. M.
Scott, Ronald A.
Shirley and Co.
Trent Gas Engine Company.
Warby, J. L.
Waygood and Co.
Wells Bros.
Western Electric Company.
Weymersch Battery Syndicate
Woodhouse and Rawson.

Bronze Medal.

Allsop and Co.
Anders Elliot and Chetham-Strode.
Appleton, Burbey, and Williamson.
Archer Pipe Company.
Becker and Co.
Bishop, W. J.
Bowron, G.
Burnby and Son.
Captaine Gas Engine Company.
Charlesworth, Hall, and Co.
Cooper, H. and J.
Croggon and Co.
Dorman and Smith.
Electric Stores, Limited
Faraday and Son.
Fowler, Lancaster, and Co.
Habgood, W. J.
Hindley, E. S.
Hookham, Townley, and Co.
Homacoustic Speaking Tube Company
International Electric Company.
Jenner, T.
Jennings, G.
Jones, A.
Lacombe and Co.
Lewis, J.
Lundberg, A. P.
Maquay Electric Light Syndicate.
Mayer, H.
Mining and General Electric Lamp Company.
Napier and Son.
Newton, F. M.
Riedel, J.
Roberts, Adlard, and Co.
Roper's Electrical Engineering Company.
Smith, Samuel, and Son.
Spencer, Edward, and Co.
Spencer, J.
Stegmann, G.
Taylor and Tucker.
Telegraph Manufacturing Company.
Thorpe, Harry.
Tipping, H. S.
"Trusty" Engine.
Wilson Hartnell.
Ziety and Co

THE "DAILY CHRONICLE" INSTALLATION.

We have assisted at a good many ceremonies and inaugurations in our time, but seldom, perhaps, never before have we had experience of such a unique and brilliant inaugural ceremony as that which was held late at night, or rather early in the morning, a week ago at the *Daily Chronicle* offices in Whitefriars-street. In the first place, the hour of the invitation—"midnight to 4 a.m."—is rather uncanny to anyone but a "high society" personage, an actor, or a newspaper man (and of all three there were abundance, too, crowding at this function) and the general interest of the exhibition—for it was one of the mighty machinery turning out newspapers by the thousands and tens of thousands at the rate of 20,000 each an hour, beside the special interest of the complete installation of electric light in every corner—all this, commingled with the brilliant scene of moving figures and familiar distinguished faces, made a scene it is not easy to forget, and one which our readers may perhaps like to partake of in fancy in print for a few moments. We will first give a general idea of the scope of the businesses here involved before describing the function we were to witness. These consist of the printing and publishing of *Lloyd's News* and the *Daily Chronicle*, together with the paper making business at Sittingbourne, the whole comprised under the title, Edward Lloyd, Limited. No weekly newspaper, perhaps, is better known or more widely read than *Lloyd's Weekly Newspaper*, a journal that has a circulation of over three quarters of a million a week, and is still growing. It is known in all parts of the civilised and uncivilised world, and is a sort of recognised medium of intercourse throughout Imperial Britain, between home and the colonies. This paper is printed on Hoe rotary printing machines on the same premises as those of the *Daily Chronicle*. This latter newspaper, one which is rapidly taking an advanced place amongst the large dailies of London, has a daily circulation of over 100,000, and is, we must acknowledge, one of the brightest and most interesting of the morning papers. The actual paper, required by tons and tons at a time, for these journals is made by Messrs. Lloyd at their paper mills at Sittingbourne, which have also been fitted up with electric light.

As it is not often, perhaps, that our readers have the opportunity of assisting at the production of the paper which they buy so easily for a penny at the stalls in the morning, as they have never gone through the process so beautifully timed and organised, with their nerves of telegraph wires stretching to the farthermost corners of the earth, constantly feeding the printing machines—they may like, before attending to the electric light, to look on, as did the visitors, at the whole process from start to finish.

Receiving the visitors at midnight in a large storeroom, fitted for the nonce with red carpet and bunting, and daintily decorated with palm leaves and flowers, is Mr. Frank Lloyd, the present head of this great business. We notice M.P.'s, authors, leading civil and business men, dramatists, artists, and editors. Among them are to be noted Mr. Dibbs (fresh from Australia), Sir A. Rollitt, Mr Causton, M.P., Sir J. Crichton Browne, Colonel Hugh Douglas, Mr Yates Thompson, Dr. Lennox Browne, Mr. Syme (editor of the *Melbourne Age*), Mr. Toole, Sir Augustus Harris, Sir Somers Vine, Colonel Byng, Mr. F. C. Gould, and Sir Frederick Abel. All Fleet-street, broadly speaking, was present—a veritable institute of journalists; and the black-coated crowd wandering at dead of night amongst the rattle of machinery and the glare of the composing room, made a curious contrast.

That quiet young man in short brown coat, chatting unconcernedly to the visitors, is Mr. Massingham, one of the best known and most influential of London journalists. We will follow him, if you please, as he slips away for a moment upstairs, about half-past one, into the quiet sanctum. A telegraph form is rapidly perused, a note rapidly penned, a proof glanced through, and a few corrections made, and the editor's work is finished for the night. We go up to the composing-room; we see the eager army of shirt-sleeved men, bending this way and that over their cases of type—the message flies into lead type, line by line, and half-a-dozen men clap their "takes" together; it is pulled in proof, read, corrected, and dropped into place in a huge iron frame, where columns more are ready for this last word, and before one can realise it, the type is knocked level, screwed up, and is sinking down the lift to the foundry. Here, indeed, is a busy, and withal a hot, scene. All are waiting like acrobats for the performance. The ovens glow with heat, the lead is melted and quivering in the foundry. The men seize the flat "forme" of set up lead type, clean it vigorously; then a thick sheet of papier mache is thrown on top, and whack, whack, a stiff brush struck all over it, makes the impress of the face of the type on the soft thick paper sheet. It is rolled, a sheet of brown paper is rapidly pasted at back; the matrix thus formed is torn off and dashed into an oven to dry. The leadfounder stirs up his melted metal and the men range themselves in file for the last effort. Out comes the paper matrix and is rapidly adjusted in a semicircular iron case: the press comes down upon it, the back of the hollow casting-box is brought sharply down upon this and screwed up with a jerk, and the whole is stood on end to receive the lead. Two swarthy founders rush up with their double-handed pot of lead, and in it goes; a jerk to settle it, a blast of cold air, and the case is opened and the semicircular stereotype is lifted out, the matrix detached to serve for another and yet two or more other stereos. The stereo itself is cut off to shape with lightning speed, its edges and inside trimmed, bits are cut out by men whose chisels seem to fly dangerously near each other's eyes. In a minute or two, certainly under five minutes of the start, the stereo is sent down by lift to the printing-room.

We run down just in time to see the last act. The huge printing machine is surrounded by attendants and as

expectant crowd. The long wide strip of paper is already adjusted through the straps and rolls, the engineer standing with his hand on the lever. The stereo is lifted, shot into place on the roll, screwed up—and the press is ready. The lever is turned and the machine begines slowly, slowly at first, rapidly increasing in speed till a deadly rattle and screech in the air prevents even shouting from being heard. The huge roll of paper at the back spins round, rushes in a grey streak up, down, and through the rolls; and at the other side, upon a revolving receiving band, come rushing out almost like grain from a sack, sheaves and sheaves of *Daily Chronicles*, printed, extra sheet inserted and gummed, and all folded ready for sale. They come tumbling out, amidst the incessant din, in heaps and heaps, ready counted into quires of 26—the salesman's two dozen—and the busy hands lift them off, stack them, tie them up, and take them into the publishing-room, where W. H. Smith and Son's waggon is waiting for the delivery. With freshly-printed copies in hand, the visitors emerge from the brilliantly lighted, screeching machine-room into the fresh air, where the cold grey of morning already gives a ghostly clearness to the deserted streets. Such is the process of production of a daily paper; and of all the printing establishments with which Fleet-street abounds, that of Messrs. Lloyd now stands very nearly, if not quite at the head.

The Electric Light Installation.

The premises of Messrs. Edward Lloyd, Limited, are very scattered, being situated partly in each of the following streets: The advertising office for the *Chronicle* is at 80, 80A, and 81, Fleet-street, this being quite separated from the other portions of the buildings, and is the most distant point from the dynamos. As to the main portion of the building, it extends from Salisbury-square on the east to Whitefriars-street on the west, and for a small portion at No. 72 it fronts Fleet-street on the north, the basement being excavated under the intervening courts—viz., Angle-court and Hanging Sword-alley.

The electric light engine-room is situated in the basement of the building fronting Whitefriars-street, being part of the *Daily Chronicle* machine room, from which it is partitioned off with a brick and glass partition. The size of the engine-room is 21ft. by 10ft. wide.

The boiler used at present is the same used for the engines which drive the printing machines, one of the two being generally found sufficient for the whole of the work, except on Friday nights, when *Lloyd's Weekly News* and the *Daily Chronicle* are both being printed, and the two sets of engines and boilers have then to be used. They work at 60lb. steam pressure.

The power is supplied by two Invincible engines, made by Messrs. John and Henry Gwynne, of the Hammersmith Iron Works. They have cylinders 13½in. diameter by 10in. stroke, and run at 300 revolutions per minute. The engines exhaust into the general superheater; they are fitted with special lubricating arrangements for continuous running.

The current for lighting these extensive premises is generated by two four-pole compound Phœnix dynamos, built by Messrs. Paterson and Cooper. These machines are mounted on the same bed-plate as the engines, and the armature shaft is coupled direct to the crankshaft of the engine. The whole arrangement forms one of the most compact plants of the size in existence, measuring only 6ft. 4in. over all in length, and the broadest part of the arrangement—viz., the magnet ring—being only 4ft. 10in., and the total height of the engine being 9ft. 2in. The four magnet coils are mounted on a cast-iron hexagonal ring; they are wound on brass bobbins which are slipped over the pole-pieces, these latter being bolted to the ring. The armature is of the Gramme ring type. The output of each machine is 240 amperes at 105 volts when running at 300 revolutions per minute. The eight brushes are mounted in pairs on spindles attached to a circular rocker, enabling both pairs to be adjusted at the same time. The brushes are made of copper gauze, and the dynamos run without the least spark.

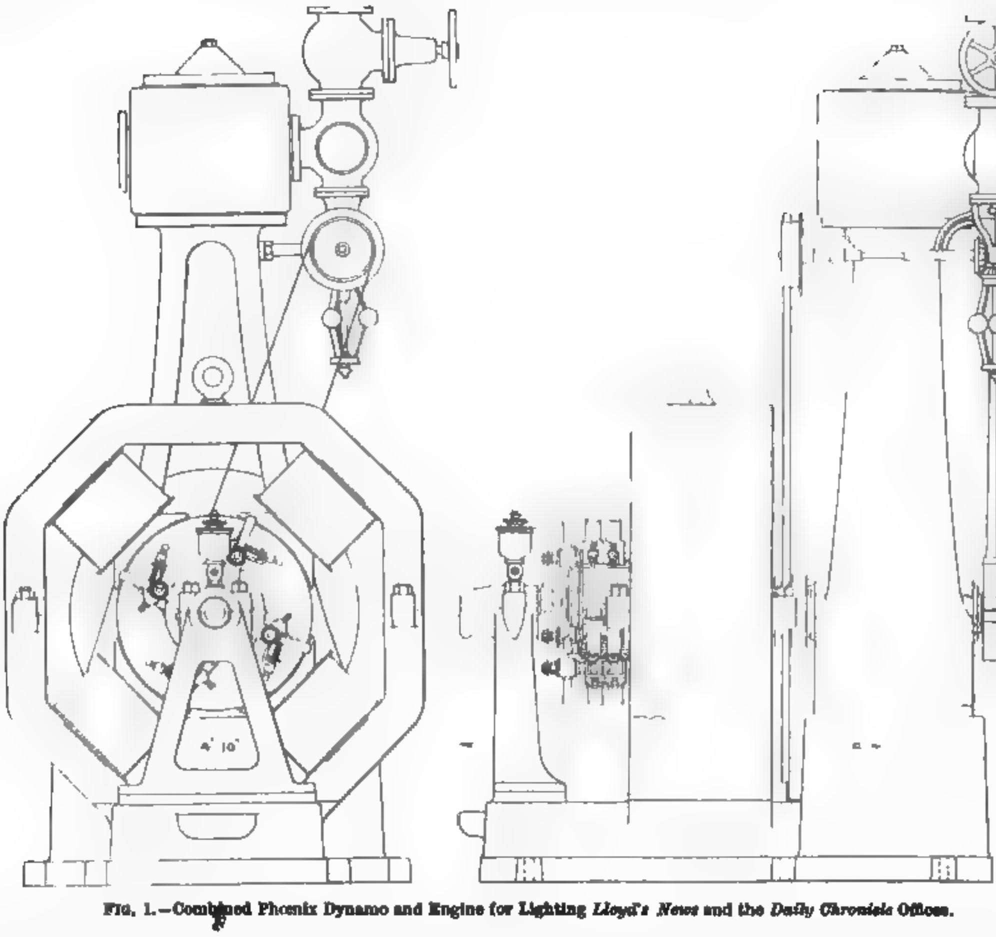

Fig. 1.—Combined Phœnix Dynamo and Engine for Lighting *Lloyd's News* and the *Daily Chronicle* Offices.

The arrangement of the plant is shown in the drawing, Fig. 1, the two engines, which are right and left handed, being placed together in the centre of the room and the two dynamos towards the outside; the switchboard is placed at one end.

The switchboard consists of an enamelled slate tablet 6ft. long by 2ft. 6in. high, mounted in a polished teak frame. This board carries the eight circuit switches for controlling the lights, with double-pole fuses to each circuit, and also

the double-pole switches and fuses for the dynamos and the instruments. The distributing switches consist of two-way spring lever switches by means of which any circuit can be switched from one machine to the other with hardly a perceptible flicker in the light; over each of these switches is placed a pilot light run from the particular circuit which it controls, so that the engineer-in charge can see exactly what circuits are on, and if they all right at a glance. Each dynamo is provided with a double-pole switch, double-pole fuses, and an ammeter. One voltmeter is fixed with a two-way switch, so as to enable the readings to be taken from either machines.

The instruments are of the Phœnix dead beat electro-magnetic type, they have 6in. dials and are direct reading respectively to 250 amperes, and the voltmeter to 110 volts.

The mains from the dynamos are carried underground, and at the back of the board is a space of 2½ft., so that the connections can be easily got at if necessary. The connections at the back of the board are made by means of copper strips.

The current is divided over the eight circuits as follows: (1) *Chronicle* composing-room; (2) *Chronicle* offices; (3) *Lloyd's* offices, (4) *Lloyd's* machine-room; (5) export and stationery department; (6) Fleet-street advertising offices; (7) *Chronicle* machine and engine rooms, (8) *Lloyd's* composing-rooms.

The "Chronicle" Composing-room is situated on the top (third) floor of the building in Whitefriars street, in the basement of which is the engine-room. The mains run from the switchboard up an air shaft into the centre of the room, where they divide into four branch circuits, each protected by two single-pole fuses; these circuits run right and left along the sides of the room, from which five-light branches are taken, each again protected by two single-pole fuses. The fittings over each composing frame consist of porcelain ceiling rose, with fuse, glazed cotton cord, with Edison Swan bayonet joint key socket-holders, and a specially made enamelled iron shade, constructed so as to throw the whole of the light into the frames, and to keep it off the eyes of the compositors. The total number of lamps on this circuit is 167 16-c.p. lamps.

The "Chronicle" Offices comprise the ground, first, and second floors of the Whitefriars-street building, including the editorial department, writers' and reporters' rooms, stereo-room, paper reel-room, and publishing offices, and also five 50-c.p. lamps in the street, four of them being fixed in "bulkhead" fittings against the wall, and the other, 50-c.p. lamp, being fixed in the lantern over the door. The total of lamps in the *Chronicle* offices amounts to:

16-c.p. lamps	139
32-c.p. lamps	3
50-c.p. lamps	5

The fittings in the above department consist chiefly of pendants, those in the writers', reporters', reelroom, and lavatories, publishing offices, and passages have opal shades; the editorial staircase gilt three-light ceiling fittings with opalescent frill shades; while the passages have large iced shades. The editors' rooms and offices have centre three-light electroliers and pendants round the sides and over the desks, with one or two table standards in each room. The ceilings being all iron and concrete, and newly decorated with ornamental cornices, rather a novel arrangement of wiring was introduced: the casing was run round the rooms under the cornice, and ceiling roses were fixed on it, from which flexible cords were carried through counterweights over pulleys fixed where the lights were required, as shown in the sketch, Fig. 2.

"Lloyd's" Office.—The circuit for *Lloyd's* office includes the whole of the buildings in Salisbury-square excepting the basement. In the private offices, etc., three-light brass ornamental electroliers are fixed, and in the other parts of the building plain opal shade pendants are used. The mains from the switchboard run up the air shaft and across Hanging Sword alley in a special covered-in box on insulators, with several other circuits. There are 80 16-c.p. lamps on this circuit, besides a 100-c.p. and a 200-c.p. lamp in Angle court. The 100-c.p. lamp is fixed in the lantern at the entrance of the court, and the 200-c.p. lamp is fitted in an enamelled iron shade, and suspended in the centre of the court.

"Lloyd's" Machine-room.—This circuit includes the whole of the various basements to the east of Hanging Sword-alley—viz., the basements of 12 and 13, Salisbury square, and of from 2 to 13, Crown-court, including the excavated portion under the court itself. The fittings on this circuit are mostly either white opal or enamelled iron shade pendants, with the exception of those lamps fixed on the machines themselves. These latter lights constitute one of the chief features in connection with the installation. A difficulty was at first experienced on account of the very rapid vibrations of the machines, which rendered the ordinary bayonet

Fig. 2.—Counterweight Pendant at the *Daily Chronicle*.

joint lampholders useless, as the lamps are found to break off at the collar after a few hours' run. This was got over by a special form of holder, as shown in the sketch, Fig. 3, the object being to support the lamp from the bulb itself, and quite apart from the connections, and to attach the lamp to the circuit by means of a flexible cord. Referring to the sketch, it will be noticed that the light frame composed of No. 10 B.W.G. brass wire is screwed to the frame of the machine at A A; to insert the lamp, the supporting ring, B B, is pressed back against the springs, S S, and the point of the lamp inserted in the hole, C, the ring, B B, being then allowed to come over the neck of the lamp. We might mention that loop lamps were tried, but they were found to burn through at the loops on account of the vibrations causing sparking at the contact

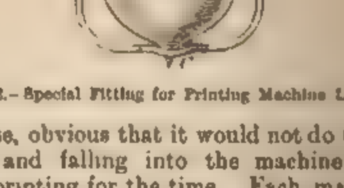

Fig. 3.—Special Fitting for Printing Machine Lamps.

It is, of course, obvious that it would not do to risk a lamp breaking off and falling into the machine and perhaps stopping the printing for the time. Each machine is fitted with eight lamps as described above, besides having eight opal shade pendants over it and a portable lamp and plug connection for the purpose of getting to the shafting, etc., underground; the two switches, one for the machine and one for the pendants, and the plug are in most cases fitted into a box and let flush into the wall, so as to be safe from breakage. There are 110 16-c.p. lamps fitted on this circuit in all, including those fixed in the new engine-room. The mains from the switchboard run through the *Daily Chronicle* machine-room and along the passage under Hanging Sword-alley into *Lloyd's* machine room.

Export and Stationery Department.—This circuit comprises the ground, first, second, third, fourth, and fifth floors of

72, Fleet-street; the first, second, third, and part of the ground floor of the block on the eastern side of Crown-court, and on the western side the export stores and offices on the first and second floors. These lights have mostly enamelled iron or opal shade pendants, with adjustable counterweight pendants in the offices, and in the private offices portable table lamps are fitted. The mains run into the main building from the two sides of Crown court, and then through the passage under Hanging Sword alley to the switchboard. The total number of lights on this circuit is 96 16-c.p. lamps.

Fleet-street Advertising Offices, 80, 80A, and 81, Fleet street, are included in this circuit, this portion of the premises being quite separated from the rest of the works. This necessitated the employment of overhead mains; they run from the switchboard, up the shaft, and over the roofs for a distance of about 200 yards, and then drop down into the offices at the back. These mains run direct to an eight-circuit distributing-board, consisting of an enamelled slate tablet mounted in a polished teak case with glass front, containing eight switches and double-pole fuses; the main office is divided into seven circuits, and the eighth is used for the clock. There are 25 16 c.p. lamps over the desks in the main office, consisting of pendants with ground-glass frills over the counters and centre desks, and jointed brackets on the wall for the side desks; in the basement there are eight 16 c.p lights, the fittings being opal shades. In the windows there are 20 32 c p. lamps, plain pendants with ground frill shades, and in the face of the clock, looking up Fleet street, there are six 32 c p lamps. The advantage of having the electric light here has been already found out, as with gas, in the old *regime*, the face required cleaning at least once or twice a week, while now it will go on for months without attention.

The "Chronicle" Machine room.—This circuit comprises the whole of the Whitefriars-street building, including the electric light engine-room, main engine room, and boiler-room. The fittings are the same as described for *Lloyd's* machine-room. The total number of lamps fixed here is 112 16-c.p. lamps.

"Lloyd's" Composing-room, etc.—In this circuit is included the composing-room proper and the editorial offices. The fittings in the composing-room are the same as are used in the *Chronicle* composing-room, and those in the editorial offices consist of three-light electroliers in the centre, with portable table lamps and plain opal shade pendants in the passages, etc. There are 105 16 c.p. lamps on this circuit.

Both engines and dynamos are always kept ready for running, although it is only found necessary to run one all the week except during the heavy work on Friday night, when the second machine is started and some of the circuits are switched on it. One engine and dynamo is kept always running night and day.

The total number of lamps in the whole installation at Messrs. Lloyd's is 848 16-c.p, 23 32-c.p., five 50-c p., one 100, and one of 200 c.p. The work of superintendence and of designing and carrying out the details of this interesting installation has been in the hands of Mr. E. George Tidd, superintending engineer to Messrs. Paterson and Cooper, and the firm deserve the very greatest credit for the admirable way in which it has been carried out.

LARNE CENTRAL STATION.

Before these lines are read this station will be running. As our readers are aware, the work was undertaken and has been carried out by Messrs. J. E. H. Gordon and Co.

The buildings, which are quite an addition to the architecture of the town, are substantially built with good hard black stone of the neighbourhood and slated with native slates. The dressings of the doors and windows are of red brick, and give a very neat appearance to the buildings, which consist of an engine-house 44ft. by 30ft. by 15ft., a boiler-house 36ft. by 30ft. by 15ft., and a coal-shed to contain 30 tons of coal. The chimney, which is square, is 4ft. 6in inside, and is 60ft. high. Round the engine-room is a stained and varnished match-boarded dado, 4ft. high, finished with bold capping. The walls above that height are cement finished, giving a handsome and effective finish to the room. The whole of the buildings, boiler settings, and concrete engine beds have been carried out by Mr. A. Bremner, the contractors' architect. The following describes the equipment of the station:

The boiler-house contains two Cornish boilers by Messrs. Penman and Co., of Glasgow. The working pressure is 80lb. per square inch. The plates are of the best mild steel, the diameter of shell is 5ft. 6in. The total length of boiler is 20ft.; the shell plates are ⅜in. thick, and are in one plate in circumference, thus removing the longitudinal seams from the brickwork, as well as placing them out of the water space; the end plates are ½in. thick. There are three Galloway tubes in each boiler.

The engines, which are made by Messrs. Combe, Barbour, and Combe, Limited, Belfast, are of the single cylinder condensing type. The cylinders are 13in. diameter by 24in. stroke, and are fitted with Corliss valves. The steam-valves are fitted with a simple and efficient trip gear of Messrs. Combe, Barbour, and Combe's own design. This trip gear is very easy of control, and entirely under the command of the engine driver, who can disconnect it at a moment's notice. It is regulated by means of a high speed governor, which is fitted with a knock-off gear, by means of which the supply of steam is entirely cut off from the cylinder, in case the speed increases or decreases beyond certain limits. The air pumps are vertical, of short stroke, and actuated from the cross-head centre by means of links and rocking levers. The frames are of strong box girder section, with target ends, against which the cylinders are bolted, thus leaving them free to expand and contract in the direction of their length. The cranks and shafts are turned out of solid steel forgings, and the crank-pin, crank-shaft, slides, and other bearings are all made abnormally large, not so much for strength as to allow large wearing surfaces, to reduce wear and tear to a minimum, and to prevent heating up. The flywheels are 12ft. in diameter, with eight grooves for ⅞in. ropes, and will run at 85 revolutions per minute, and their weight is three tons. Cotton ropes are used for driving. The polished parts of the engine, with the exception of the crank-shaft, are all electro-nickel plated to prevent rust, and the whole of the engines are of neat design and well finished.

The alternators are two Mordey-Victoria machines of 25 kilowatts, running at 900 revolutions per minute; each alternator is excited independently by means of an exciter attached to the end of the alternator shaft. The E.M.F. is 2,000 volts.

The switchboard is of wood, is well made, and is 11ft. long and 3ft. 6in. high. The switches, fuses, etc., are all mounted on their own incombustible bases, and the volt and ampere-meters are on bases of their own, standing above the top of the switchboard.

The current is distributed by two pairs of high tension mains, $^7/_{16}$ cable in lead, made by the Fowler-Waring Cable Company, one circuit is 1,700 yards long, and has five transformers, three of 4 e.h.p. and two of 2 e.h.p, fixed on poles at various distances along the circuit—the three 4 h.p. feeding one pair of low-tension mains all in parallel, the two 2 h.p. each feeding their own mains, low tension, which is 100 volts. The other pair of mains, high tension, go from the station direct to a distributing centre 700 yards away, and feed at present four 4-h.p. transformers, but there are an extra pair of cables provided on this circuit, and the distributing centre is built to contain 12 4-e.h.p. transformers; the four 4-h.p. transformers here feed into a low-tension network which is well provided with double-pole copper fuses. These fuses are placed in convenient places for repairs.

The transformers used are of two sizes, 4 e.h.p. and 2 e.h.p., of the Mordey-Victoria type, and will work the three-wire system, 50 or 100 volts.

The whole of the buildings have been built with the intention of putting down another alternator and engine.

The town is at present lighted with 11 arcs (Brockie-Pell), which are very steady, and 50 incandescents.

The whole of the plant (including engines, boilers, and alternators) have been erected under the superintendence of Mr. W. M. Furniss, the company's resident engineer.

THE

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CONTENTS.

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 Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vols. I. to VIII. inclusive, new series, of "The Electrical Engineer" *are now ready, and can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.*

CYRUS FIELD.

The news from America as to the health of Cyrus Field induces us to call attention to this remarkable man. He is, perhaps, the only representative of those pioneers of ocean cable finance who can claim the sympathy of two worlds. His early surroundings cannot enable us to say that he was cradled in the lap of luxury, and in his latest days he has lost his fortune through the speculative dealings of his son. During the years of his early and mature manhood Mr. Cyrus Field looms before us as a giant in initiating enterprise, in stemming disaster, and in bringing the enterprise to a successful issue. To Cyrus Field, more than to any man living or dead, Atlantic telegraphy owes its success. He preached submarine telegraphy much as Booth preaches the welfare of the residuum. He convinced friends and enemies as to the possibilities of the venture, and he obtained support where others said "impossible." A more consummate master in the art of plodding onwards through evil and through good report cannot be named. He had his reward in the success of Atlantic telegraphy, in the possession of a large fortune, in the honour and respect of those from whom honour is valued. That his fortune is gone is due to no fault of his—in fact, it adds to a due appreciation of the man for the loss is due to his love for, and his trust in, his son. In these days of hurly-burly strife—for lighting and traction—in the days of high volts and many amperes, submarine telegraphy as it appeared in the days prior to the Russian War can hardly be understood. With us it is a thing of little account, then it was a plunge into the vast unknown. Cyrus Field was the leader who led into the unknown, and who, like Columbus, had an overpowering personality. His followers might fret, might fume, might want to turn back from fright, but the goal was in the unknown, and into the unknown they had to go. Such are the men who make history. They require to be convinced, but once convinced there is no looking backwards, but a persistent forging ahead till the enterprise is won. From 1854 to 1866 Mr. Cyrus Field laboured to obtain Atlantic telegraphy. The cable in the latter year proved the link that has not since been severed. He had during these years to witness failure after failure. In 1857 the first attempt to lay a cable across the Atlantic was made. The attempt failed. With the knowledge of to-day, the wonder is that the attempt was made. It could end in nothing but failure, but, then, as now failure really spelled success. One by one the weak points were discovered, one by one they were remedied, till in 1866, as we say, a cable was satisfactorily laid across, and a cable that had been lost in the previous year was picked up, spliced, and completed.

Writing of the 1865 disaster Cyrus Field says "For twelve hundred miles she (the "Great Eastern") rode the sea in triumph, till in a sudden lurch of the ship the cable snapped, and once more all our hopes were

In the deep bosom of the ocean buried."

Fresh capital to the extent of six hundred thousand pounds was to be obtained, of which five hundred

thousand pounds, the cost price, was the sum the T. C. and M. Company required to manufacture and lay another cable. Besides this the contractors were, if successful, to have in shares and cash a profit at the rate of 20 per cent. upon such cost. Although efforts will be made to guide the praise into other directions, there is no doubt but that the whole merit of persistency was due to the indomitable will and energy of Cyrus Field. After this, the last of the failures, he urged, as he urged in 1857, the continuation of the effort, and he again succeeded in gaining his way. As we have said, the year 1866 saw the consummation of his labours. Atlantic telegraphy was indeed accomplished, and in less than a quarter of a century ceased to be regarded as anything extraordinary. The world can cheer the last days of the pioneer by granting that meed of honour and respect due to one whose work has changed the course of business in modern times. In his declining years, in the hours of his despondency, he needs the expression of sympathy from those who recognise the value of his labours :

Then, to this day, be honours paid
  The world's proud conquerors never knew ;
Their laurels shrink, their glories fade,
  Exposed to reason's sober view.
But reason, justice, truth rejoice
  When discord's baneful triumphs cease,
And hail with one united voice,
  The friend of man, the friend of peace.

ELECTROLYTIC CHEMICALS.

Electricity has already invaded to some extent the domains of commercial chemistry, but nothing approaching the amount it is likely to accomplish very shortly, if we are to believe the signs of the times. In electric smelting, and the production of pure copper and of aluminium and of zinc, we have had important application, though this is perhaps rather metallurgy than chemistry. Electricity is affecting chemical works in two directions—in the employment of electrical appliances in the factories, an instance of which we gave lately in the production by Armstrong's Glass Company, at West Bromwich, of large welded glass vessels primarily designed for accumulator cells. Electric light and electric motors have penetrated thereto as to other industries. But we speak now of actual chemical processes, of which, perhaps, the bleach and alkali production are of the most important. In these two branches alone there are invested for chemical manufacture in England not less than twenty-two million pounds sterling of capital, and this enormous industry is quite open to be entirely revolutionised at any time—and possibly not far distant—by the introduction of economical electrolytic processes of production. The subject is a fascinating one to dwell upon, but we must content ourselves for the present in pointing out the vast scope of the field for electrical application which lies before the electro-chemist, ready and waiting for harvest. These industries are presided over by keen business men, fully alive to the necessities for progress in improved and cheaper methods of production. By uniting the energies of chemists and engineers, a wonderful saving in first cost is a result to be safely expected, to the great increase of business and profits for both.

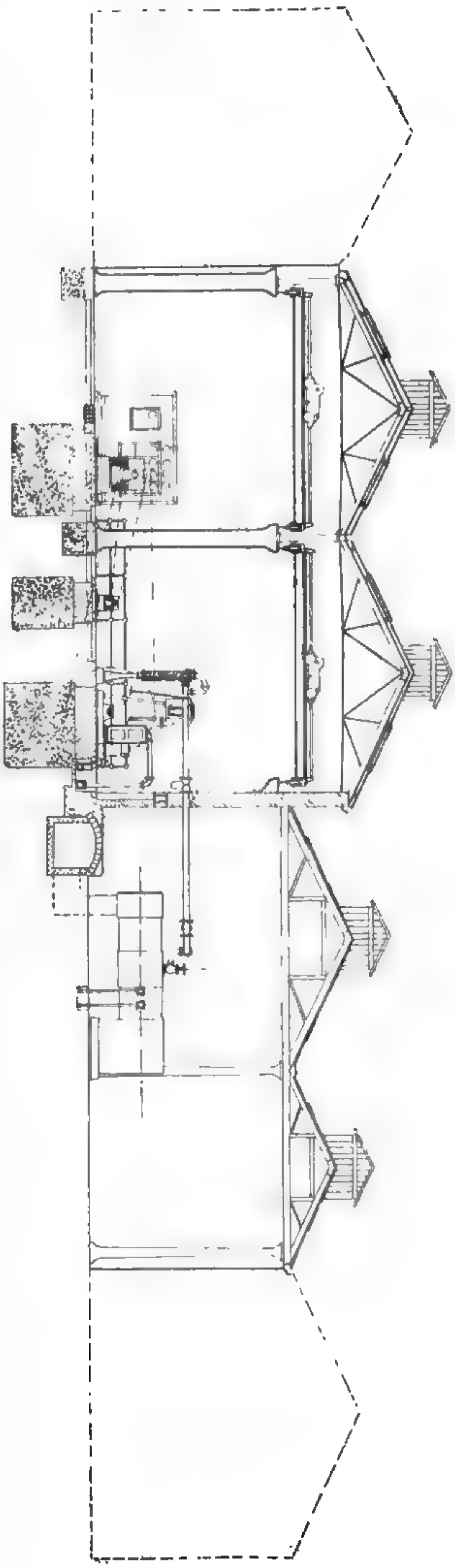

FIG. 11.—Elevation of Oxford Central Station at Osney.

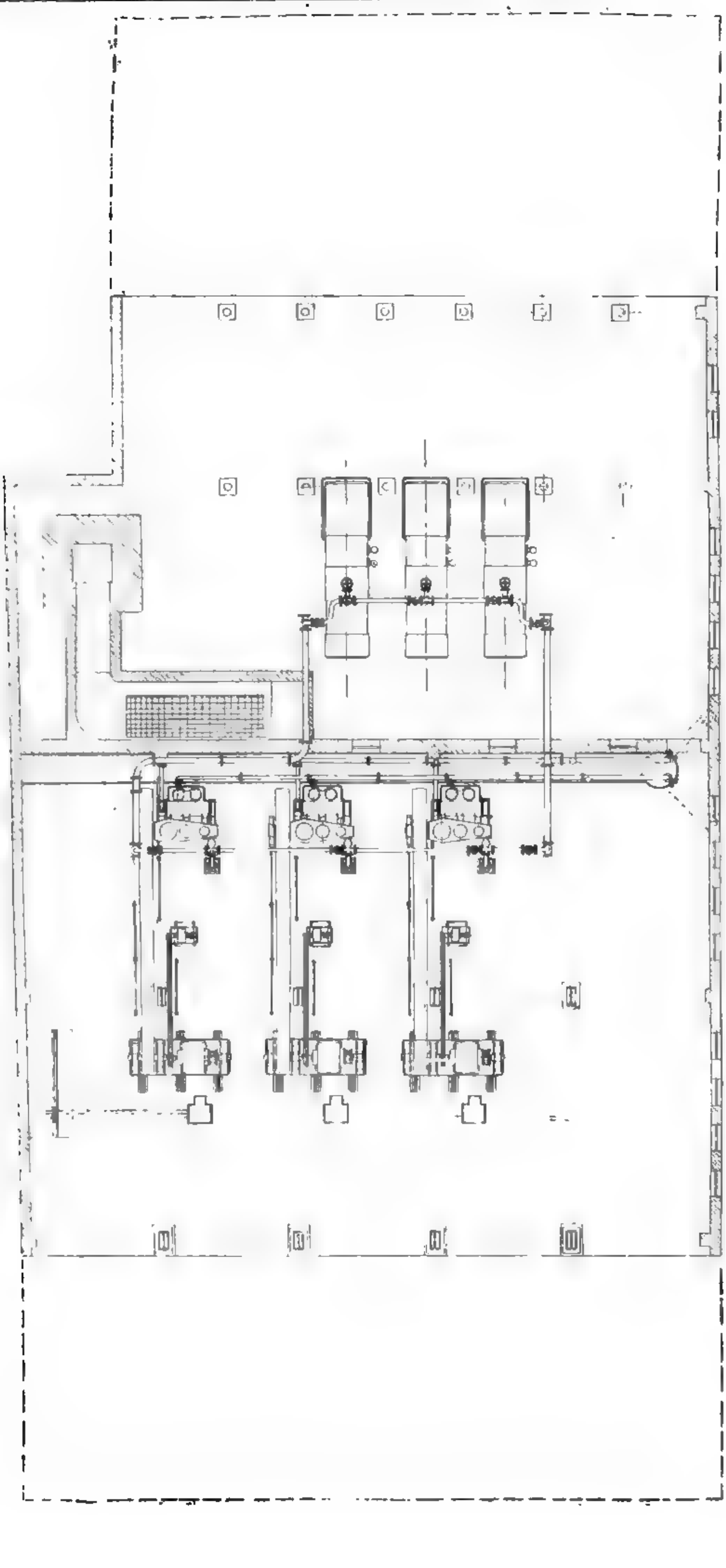

FIG. 12.—Plan of Oxford Central Station at Osney.

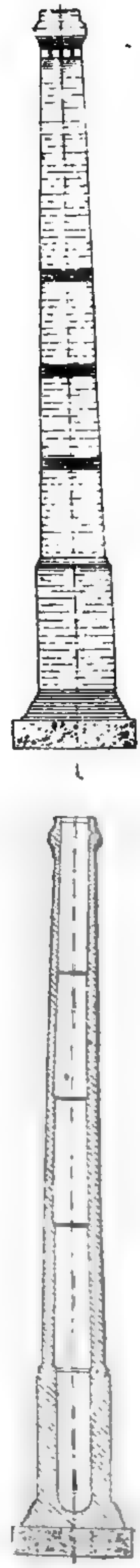

FIG. 13.—Chimney Shaft.

CENTRAL STATION AT OXFORD.

The details of this station are interesting. Our Fig. 1, page 5, showed the elevation to the river. This is built with blue brick in cement, 2ft. above high-water level to plinth, and above plinth with white bricks and red brick bands, arches, doors for unloading coal, charging launches, etc. There are 10 windows, each 5ft. by 3ft. A plan and elevation of the building is shown in Figs. 11 and 12 herewith, also sectional elevations through boiler and engine-house respectively, Figs. 13 and 14. The chimney shaft is shown in Fig. 15. The shaft is 125ft. high, square on plan, standing on a bed of cement concrete 20ft. by 20ft., and 5ft. thick, built of local bricks, with blue bands 1ft. 6in. deep every 25ft. The head is of brickwork, with York stone coping. The boiler-house, 68ft. by 51ft., is roofed in two spans on 12ft. 9in. diameter columns, framed principals, with skylights, louvres, etc., as in engine-house. The flues from boilers and economiser are partly underground. The floor is laid with Wilk's patent metallic paving. The engine-room is 80ft. by 58ft., with roof in two spans carried on eight stanchions 3ft. wide (to carry two six-ton cranes), and short columns 9in. diameter on top of stanchion, with Keay's patent iron principals and wood purlins and rafters, covered with blue slates. Ventilation is obtained by eight towers, 5ft. by 5ft. by 3ft., on the ridge, and four skylights, by 60ft. by 5ft., having wood bars and glazed with Hartley's rolled plate glass.

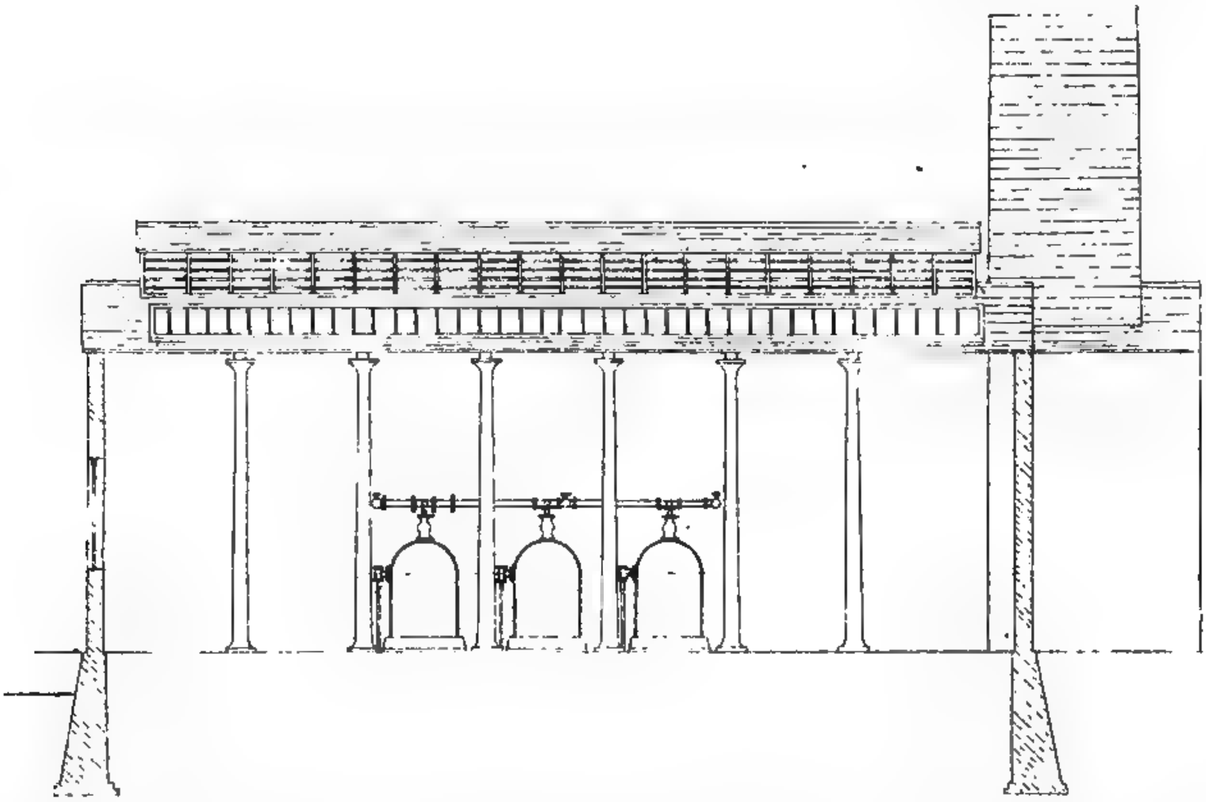

FIG. 13.—Sectional Elevation through Boiler-Room, showing also Ventilator and Skylight.

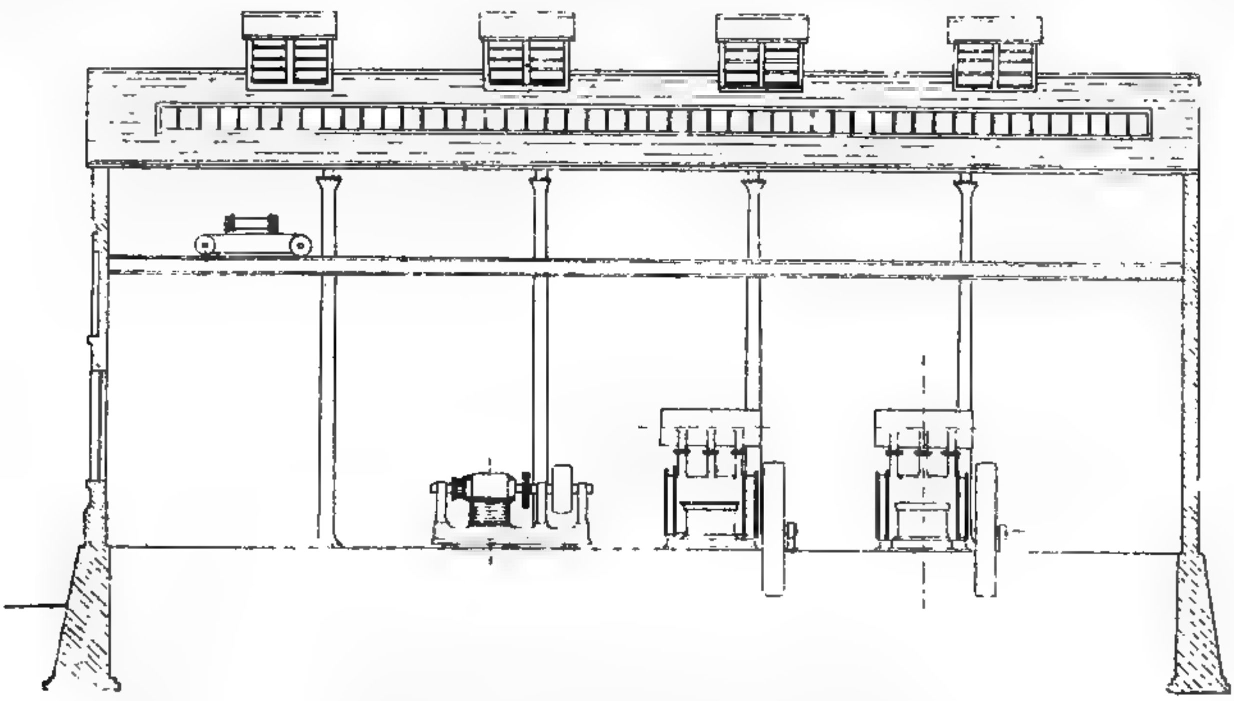

FIG. 14.—Sectional Elevation through Engine-Room, showing also Ventilators and Skylight.

The machinery and stanchions stand on cement concrete 10ft. thick, the flywheel and governor wheel races are in

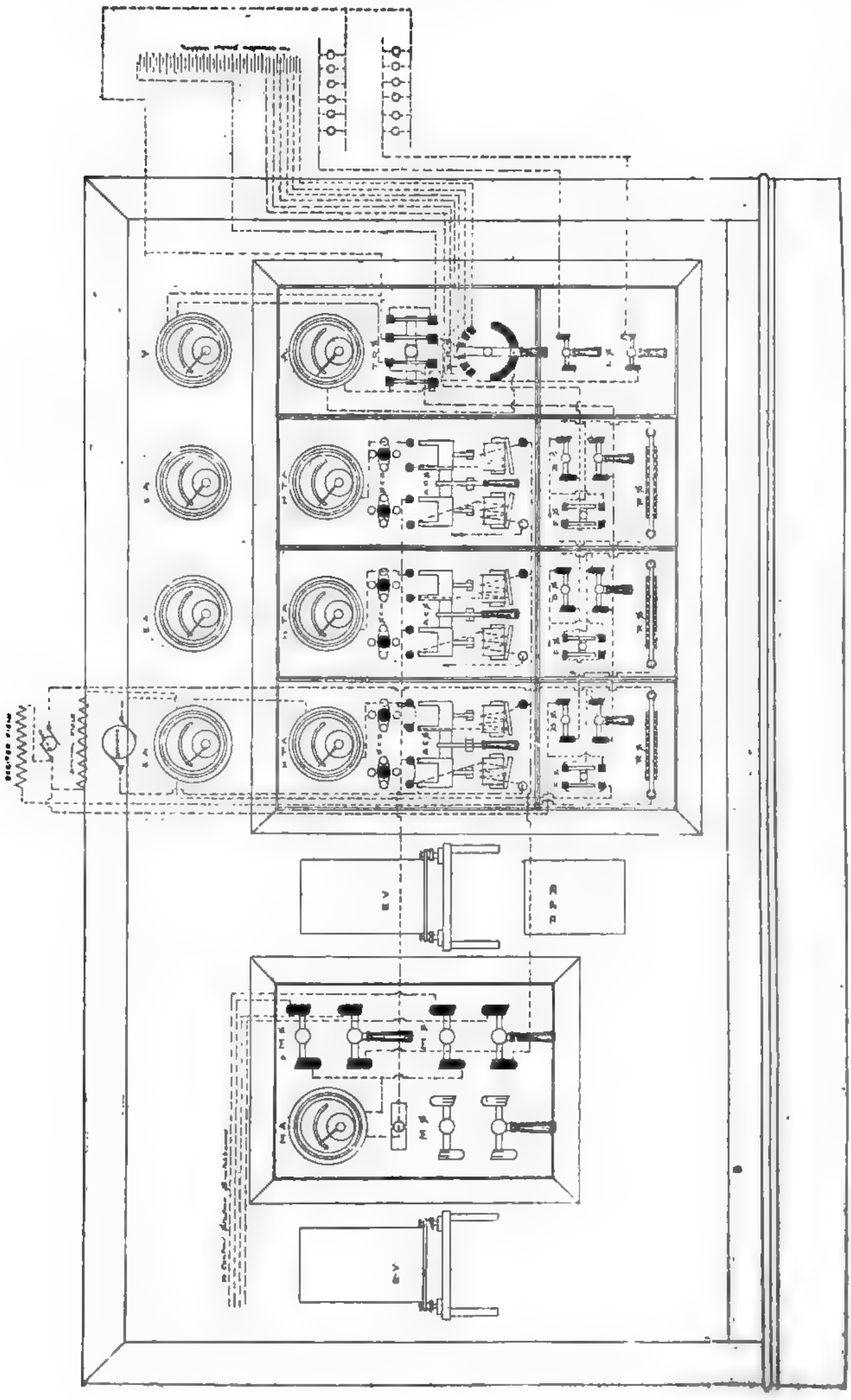

Fig. 16.—Switchboard at Central Station.

E A, Exciter Ammeters. H T A, High-Tension Ammeters. S C P, Ammeter Short-Circuiting Plugs. A C S, Automatic Cut-out and Main Switch. F S, Magnet Field Circuit Switch. B S, Double-Pole Switch to Battery Circuit. R S, Regulating Resistance Switch. V, Battery Voltmeter. A, Battery Ammeter. T O S, Throw-Over Switch for Charging Batteries. B R S, Battery Regulating Switch. L S, Lamp Switches. E V, Electrostatic Voltmeter. M A, Main Ammeter. M S, Main Switch to General Station Circuit. D P R, Dynamo Plug Board in High-Tension Voltmeter Circuit.

blue bricks, and the floor in wood blocks. The dotted lines show space for extensions. We may repeat that Mr. Kingerlee was contractor for the building, with Mr. F. Maycock as forman of the works.

Baker-street. Fig. 17 shows the left-hand portion an Fig. 18 the right-hand portion. It is, of course, necessar to give these illustrations on as large a scale as our page will admit to make the connections clear.

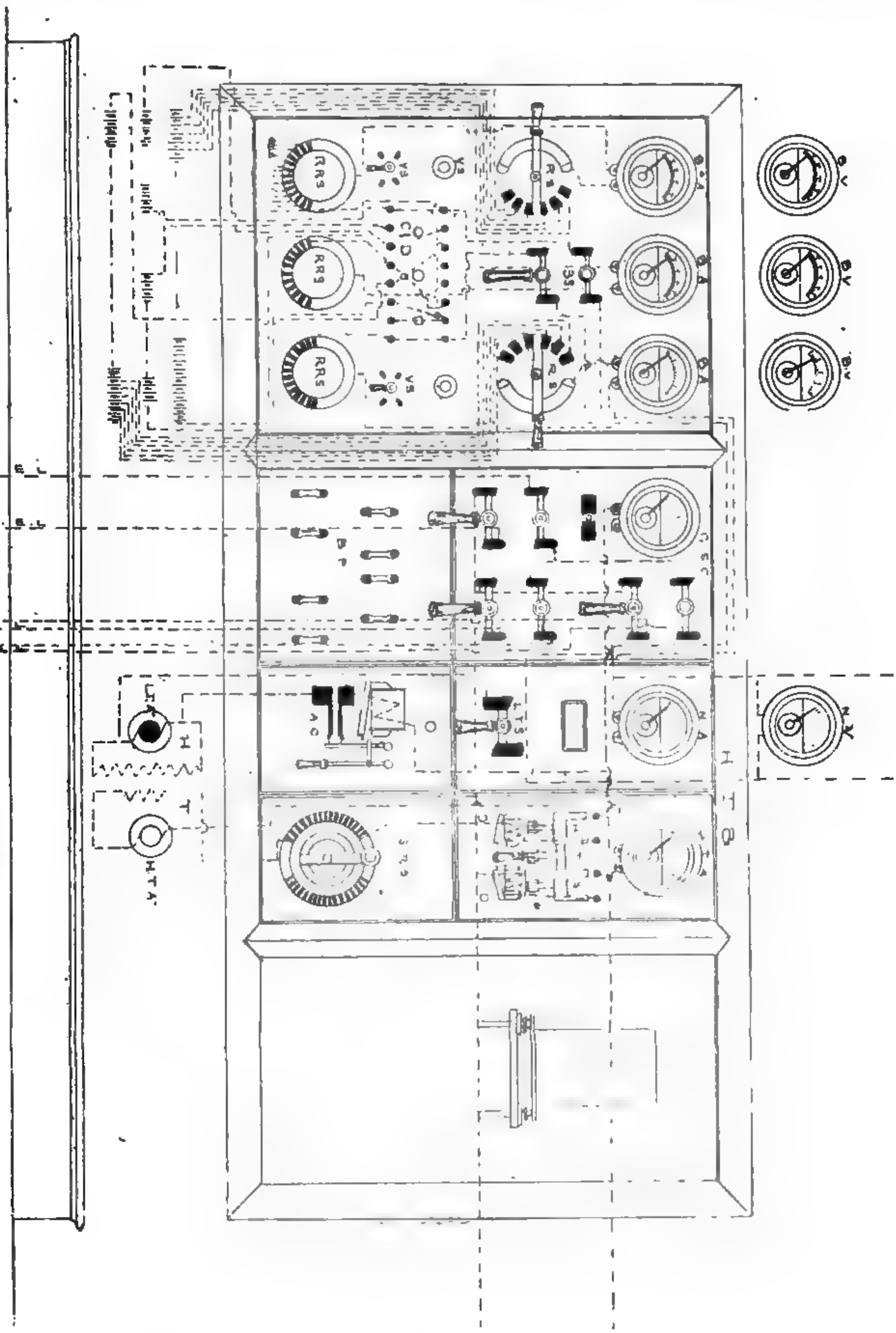

FIG. 17.—Left-hand Portion of Switchboard at Central Switch Station.

B V, Battery Voltmeters. B A, Battery Ammeter. R S, Regulating Switches. B S, Battery Switch. V S, Voltmeter Switch. C and D, Throw-Over Charge and Discharge Switch. R R S, Regulating Resistance Switch. G S C, Main Ammeter and SwitchesGenerating Station Circuits. H T B, Home Transformer Boards. N A, Network Ammeter. N V, Network Voltmeter. H T A, High Tension Ammeter H T S, High Tension Automatic Cut-out and Switch. S R S, Starting and Regulating Resistance Switch. H T, Home Transformer. P V, Pilot Voltmeters. L T O, Low-Tension Operating Switch. H T Ar, High-Tension Armature. L T Ar, Low Tension Armature. L T S, Low-Tension Switch. A C, Automatic Cut-out. F E L, Future Extension Leads. G S L Generating Station Leads. L T N Low-Tension Network. B F Battery Fuse.

Fig. 16 shows the switchboard arrangement at the central station. An examination of the illustration, and a glance at the reference letters, will make the arrangement far more clear than any amount of written description. The same may be said of Figs. 17 and 18, which show the switchboard as employed at the central switch station at

The cables which carry the current from the central station to the switch station at Broad-street are of the Silvertown Company's make. At the Broad-street station, as we have said, there are installed two sets of accumulators and a continuous-current transformer. The accumulators are capable of discharging at the rate

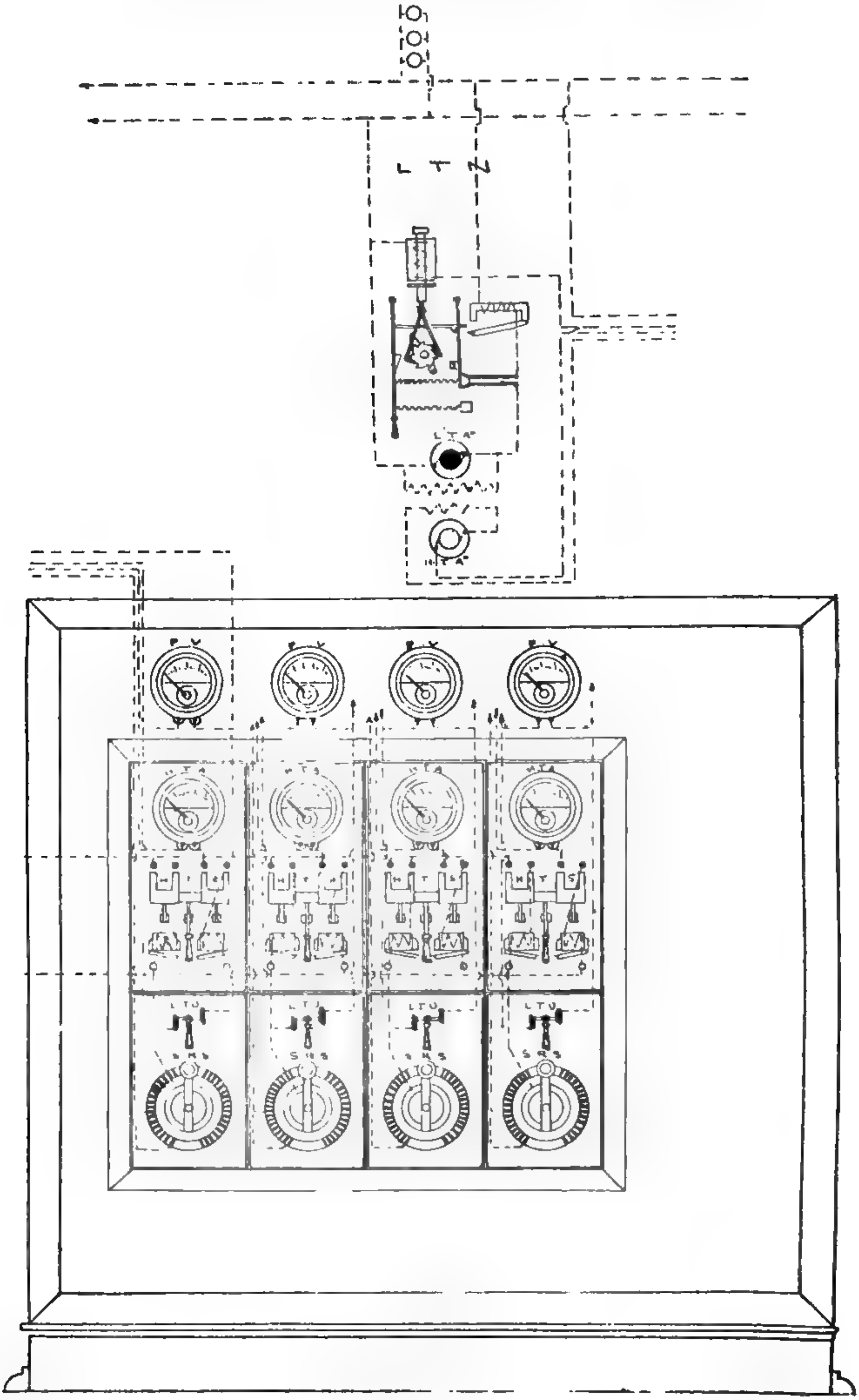

Fig 18.—Left-hand Portion of Switchboard at Central Switch Station, with Diagrammatic Illustration above of Magnetic Switch and Cut-out. (For references see Fig. 17).

120 amperes for eight hours. The transformer is designed to run from a 1,000 volt circuit, and to give 110 volts 360 amperes on the secondary circuit. All the transformers are fitted with oil pumps, and as the brushes require no lead, the machines want but little attention. Similar transformers are placed in Queen street and King street, and are started and stopped by means of the switch gear at the Broad street station. At Broad street voltmeters show the pressure in the consumers' network. When the demand requires, and it is necessary to feed from the transformer, the electrician in charge closes a double-pole switch, which starts the transformer as a series motor, the field being fully magnetised by a few turns of the high pressure mains, as was the case with the transformers in the machine-room at the Palace. A circular resistance switch allows a considerable resistance to be put in circuit at first till the motor gets up speed, and excites its own field by its shunt coils. When the shunt coils obtain their full strength, the speed is automatically kept down to 500 revolutions per minute. Fig. 19 shows a very ingenious magnetic switch and cut-out, used to put the generating circuit on to the supply circuit. A small switch at the switch station is closed, thus short-circuiting the pilot voltmeter and passing a small current through a large iron-clad solenoid coil, which is always in the voltmeter circuit. The core and iron disc of the solenoid armature carry two pawls, which engage a ratchet wheel. With the up stroke of the armature one pawl pulls a tooth and with the down stroke the other pawl pushes another tooth. The movement of the ratchet wheel actuates a cam to act on a double switch, and thus to connect the transformer to the supply mains. The circular resistance before referred to for controlling the starting current is arranged so that coils of low resistance but capable of carrying the whole current can be put into circuit to control the voltage. An automatic cut-out carrying the whole low-pressure current is provided. In the event of a heavy short circuit the armature of the solenoid is lifted, strikes a tooth of the cam, and breaks the connection between the transformer and the supply circuit. When the transformer supply is no longer needed the attendant puts a resistance into the high pressure circuit until the speed drops and the ammeter shows no current going into the mains. Then the short-circuit switch is closed and opened, causing the ratchet wheel to move round, and the cam passing forwards releases the main switch.

FIG. 19. Magnetic Switch.

FIGS. 20 AND 21. Arc Lampposts.

At the time of opening only four or five arc lamps were temporarily erected at various points in the streets. The lamps are of the well-known Brockie-Pell type. The lampposts it is arranged to erect permanently are illustrated in Figs. 20 and 21.

We must congratulate Mr. J. Ofler for his untiring energy in pushing this scheme forward, Mr. T. Parker and the Construction Corporation for the admirable work done, and trust that Oxford will respond to their advances. The way may be long, but it should be sure. So far as the design and the work is concerned there should be no doubt about its success. The only thing needed is the patronage of the Oxford public.

The National Telephone Company have decided to co-operate with the Postmaster-General with regard to the acquisition by the Government of trunk mains.

REPORT OF THE FRANKFORT COMMITTEE.

The report of the Testing Committee of the Frankfort Electrical Exhibition has been received by the directors of the exhibition, who have forwarded to us a copy of this report, embodying the figures obtained from the tests of the transmission of power from Lauffen to Frankfort.

The work of the committee extended to three installations. The first, that of the celebrated Lauffen-Frankfort multiphase-current transmission, carried out in conjunction by the Allgemeine Company, of Berlin, and the Oerlikon Company, of Zurich, comprised the transmission of power electrically from the Wurtemburg Cement Works at Lauffen, on the Neckar, to the exhibition grounds at Frankfort. The power of the waterfall was about 300 h.p., and the distance 175 kilometres (about 110 miles). The measurements were made by the members and assistants of the Testing Committee, composed of Prof. Dietrich, Dr. Feussner, Dr. Heim, Dr. Kopp, Herr Nizzola, Herr Schmoller, Prof. Stenger, Prof. Teichmann, Prof. Voit, and Prof Weber.

The second transmission of power was installed by the Deutsche Elektricitätswerke of Aix-la-Chapelle (Garbe, Lahmeyer, and Co.). The power, furnished by a 20-h.p. engine in the Palmengarten, Frankfort, was transmitted to the exhibition, where it was used to drive a motor in the exhibition; the distance was about two kilometres (about 1¼ miles), the current being high-pressure continuous. The tests in this case were taken by Prof. Brauer and Dr. Wirtz, members of committee, and Herren Friese, Stapelfeldt, and César, assistants.

The committee also examined the installation erected by Lahmeyer and Co., of Offenbach, near Frankfort, but the tests were too few to make it desirable to publish the results.

The complete description of the tests, as well as of the methods and instruments employed, will be given in the official report, which will be published when the work of the committee upon them is finished.

Table I., given herewith, gives the results of the Lauffen-Frankfort transmission; the last column gives the total efficiency—that is, the percentage of the energy supplied to the lamps at Frankfort to the energy taken from the axle of the turbine at Lauffen.

The same tests for the second transmission plant are given in Table II., the efficiency being the comparison of the work measured at the brake on the axle of the motor and the electric energy at the terminals of the generator.

TABLE I.—Lauffen to Frankfort.

Time.	Turbine H.P. given out.	Dynamo. H.P. given out.	Dynamo. Effic'ncy.	Primary transformer. H.P. given out.	Primary transformer. Effic'ncy.	Line loss in H.P.	Secondary transformer. Energy received.	Secondary transformer. Energy given out.	Secondary transformer. Effic'ncy.	Total efficiency. Between terminals of generator and the motor.	Total efficiency. Between axle of turbine and the motor.	Weather.
	H.P.	H.P.	Per cent.	H.P.	Per cent.	H.P.	H.P.	H.P.	Per cent.	Per cent.	Per cent.	
11 Oct. 1:30 to 1:40	120·9	108·1	89·4	102·4	94·7	7·3	95·1	89·5	94·1	82·6	74·0	Bright, dry.
,, 1:50 ,, 2:0	121·1	108·3	89·4	102·6	94·7	7·6	95·0	89·4	94·1	82·4	[illegible]	
12 Oct. 1:35 ,, 1:45	127·0	114·4	90·0	108·7	95·0	8·0	100·7	95·1	94·4	[illegible]	74·9	Dull, frequent rain.
,, 1:50 ,, 2:0	127·5	114·8	90·0	109·0	95·0	8·1	100·9	[illegible]	94·4	82·9	[illegible]	
,, 2:10 ,, 2:20	99·3	86·8	87·4	81·5	93·9	5·0	76·5	71·4	93·3	[illegible]	71·9	
13 Oct. 9:50 ,, 10:0	105·9	93·3	88·1	87·7	94·0	6·0	81·7	76·3	93·4	[illegible]	72·1	Rain till noon.
,, 10:5 ,, 10:15	105·9	93·3	88·1	87·7	94·0	5·9	81·8	76·4	93·4	81·7	72·2	
14 Oct. 10:45 ,, 10:55	151·8	139·1	91·6	132·8	95·5	12·8	120·0	114·0	95·0	81·8	75·1	Dry.
,, 11:0 ,, 11:10	151·7	139·0	91·6	132·7	[illegible]	12·5	120·2	114·2	95·0	82·0	75·3	
,, 11:35 ,, 11:45	194·7	182·2	93·5	175·1	96·1	24·4	150·7	144·2	95·7	79·1	74·1	
,, 12:30 ,, 12:40	197·4	184·8	93·5	177·6	96·1	25·2	152·4	145·8	95·7	78·8	73·9	
,, 1:30 ,, 1:40	117·6	104·9	89·2	99·2	94·6	7·5	91·7	86·2	94·0	82·0	73·3	
,, 1:45 ,, 1:55	112·7	100·1	88·8	94·5	94·4	6·9	87·6	82·2	93·8	81·9	72·9	
,, 2:30 ,, 2:40	78·2	66·1	84·5	61·1	92·5	3·1	58·0	53·5	92·2	80·9	68·5	
15 Oct. 10:53 ,, 11:3	190·7	177·9	93·3	170·8	96·0	25·5	145·3	138·9	95·6	77·8	72·8	Rain in early morning.
,, 11:5 ,, 11:15	190·0	177·3	93·3	170·2	96·0	24·9	145·3	138·9	95·6	78·1	73·1	
,, 11:20 ,, 11:30	189·7	177·0	93·3	169·9	96·0	24·6	145·3	138·9	95·6	78·1	73·2	

TABLE II.—Palmengarten to Frankfort Exhibition, October 15th, 1891.

Primary station. Generator. Volts at terminals.	Amperes.	Watts.	Revolutions per minute.	Secondary station. Motor. Volts at terminals.	Amperes received.	Watts absorbed.	Revolutions per minute.	Load on brake lever. Kilogrammes.	H.P. of motor.	Efficiency of motor. Per cent.	Total efficiency. Per cent.
1,107	13·95	15,442	511	1,045	13·95	14,578	370	15	17·44	[illegible]	83·10
1,124	13·90	15,624	519	1,043	13·90	14,464	375	15	17·68	[illegible]	83·30
977	10·55	10,307	528	932	10·55	9,832	[illegible]	5	11·87	[illegible]	84·70
992	10·75	10,664	526	927	10·75	9,965	361	5	[illegible]	[illegible]	82·70
1,001	10·90	10,911	527	934	10·90	10,181	364	5	12·07	87·30	81·40
970	9·70	9,408	539	899	9·70	8,720	402	0	10·52	88·70	82·10
946	[illegible]	9,129	538	884	9·65	8,531	[illegible]	0	10·24	88·40	[illegible]
941	9·65	9,081	536	896	9·65	8,646	400	0	10·46	[illegible]	84·90
194	1·50	291	560	175	1·50	262·50	431	Running light	—	—	—

The resistance of the circuit was 5·9 ohms.

The above-mentioned tables are signed: Table I., by Prof. H. F. Weber, of Zurich; and Table II., by Dr. Wirtz, of Darmstadt.

A second committee, under the presidency of Prof. Kittler and Herr Lindley, engineer to the city of Frankfort, carried out, after the close of the exhibition, another series of measurements with the idea of determining the efficiency of the plant at voltages of 25,000 to 30,000 volts, and of examining the phenomena produced under these conditions.

The report of this committee will form part of the general report of the directors of the Frankfort Exhibition.

LITHANODE TESTING BATTERY.

For many laboratory and manufacturing purposes it is necessary to have for testing purposes a high voltage. This is the case with insulated wire manufacturers, and some time since the British Insulated Wire Company, through their engineer, Mr Yeaman, late of Liverpool, had fitted up a testing set of secondary batteries to give 1,000 volts The accompanying illustration, Fig. 1, made from a photograph, shows the battery arrangement.

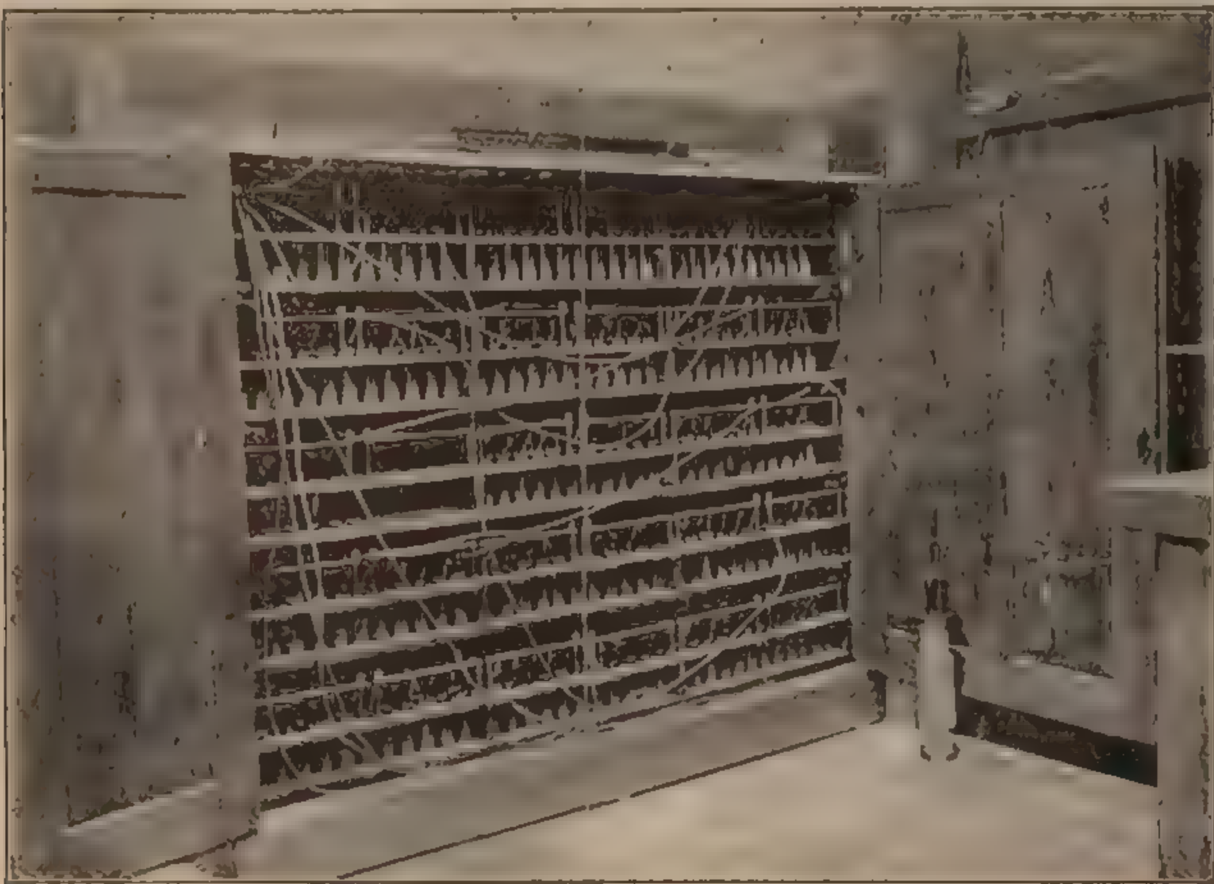

FIG. 1.

This battery consists of 500 glass cells, of the type shown in Fig. 1, mounted in sets of 100 in five trays. Each tray is subdivided into three sections of 33, 33, and 34 cells respectively. This arrangement is for convenience of charging from a 100 volt circuit. Each tray, which is constructed of a light pitch pine framework, is mounted on four small oil insulators, and the white metal connecting bars are supported on corrugated vulcanite pillars about 3in. long and ¾in. diameter. The set of five trays are enclosed within a pitch-pine wood cabinet, which is quite fume-proof. The cabinet thoroughly coated inside with shellac varnish,

FIG. 2.

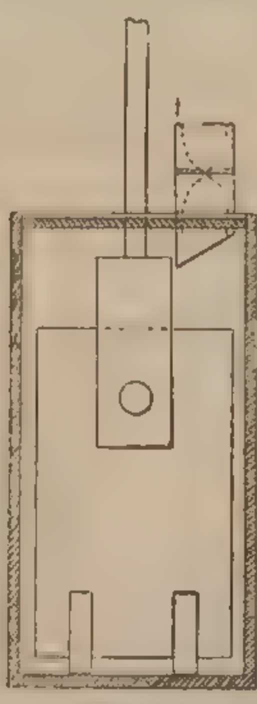

FIG. 3.

FIG. 4.

and is French polished outside, and fitted with lock and key. To ensure perfect insulation from the earth, the containing cabinet is mounted on four large oil insulators.

The capacity of each cell is just one ampere-hour if discharged at a rate of not exceeding 0·2 ampere, but the cells are capable of being discharged at a rate of from 0·5 to 1·0 ampere, with but a slight fall of E.M.F. By the arrangement of grouping, any number of volts may be obtained, commencing from 66 up to 1,000. To prevent any possibility of corrosion due to acid fumes, all the internal metallic fittings are made of a special inoxidisable white metal, and no corrodable metal of any description enters into the construction of this battery. Every precaution has been taken to ensure perfect insulation and reliability. As an example of testing battery whose cells are each capable of developing a constant E.M.F. of two volts, even when a considerable amount of current is taken from it, this battery certainly stands alone.

In actual work at Prescot, one tray per day is charged in rotation, so that the whole battery is charged once a week. The charging current is at a pressure of about 75 volts and 0·2 ampere. The insulation of the battery as it stands is about 2,000,000 ohms, quite sufficient, Mr. Yeaman says, for his ordinary work. We understand this battery, supplied by the Lithanode and General Electric Company (late the Mining and General Electric Lamp Company), has given great satisfaction, and we have no doubt its advantages, which can easily be seen, will commend themselves to other users.

In addition to the above, the British Insulated Wire Company have some sets of the vulcanite lithanode testing cells, shown full size in Figs. 3 and 4. These unique little cells are mounted in trays, containing 10 cells in each, and are therefore capable of giving 20 volts—a potential very suitable for laboratory use. These small tray batteries are exceedingly light and compact, and are, we believe, the smallest and lightest form of practical testing cell giving an E.M.F. of two volts ever constructed. In all cases the latest type of lithanode is used. This material is vastly superior to that formerly made.

TRADE NOTES AND NOVELTIES.

Our American namesake has for a long time given brief descriptions of minor pieces of electrical apparatus under this heading, and we venture to adopt the title. The decision to instal the electric light does not mean that expenditure ceases with the purchase of a dynamo, a gas engine, or a steam engine. These are the big items: there are hundreds of other items, from a staple to a meter, and the purchase of these things means business in manufacturers' shops.

Insulating Saddle Staple.

Messrs. Moses and Mitchell are introducing a staple (illustrated below) under this name, the inside bend of which has an insulating covering of vulcanised fibre. The staple is intended

to be used in fastening electric light conductors and telephone and district messenger wires in mouldings, on timber, back boards, and switchboards; also telegraph wires in towers and offices; also burglar alarms, annunciator and all other low pressure wires within the walls of buildings, especially in basements and places liable to moisture. The insulating saddle staple will not cut the insulation of wires, either by the immediate action of the driving blow, or subsequent gradual pressure on the compressed and somewhat flexible wrapping, and therefore the consequent leakage, either to ground or the opposite pole, over the surface or through the mass of partially conducting supports, or by direct contact of the staple with ground or a conductor, is done away with, and the electrolytic action set up between the copper and iron by the presence of moisture and tending to transfer a portion of the copper through the covering and deposit for some distance around the naked metal staple, which action results in eating away the wire finally to a needle point, heating the reduced section until it melts and arcs, with a probability of setting the surroundings on fire, is entirely avoided.

PROVISIONAL ORDERS.—SESSION 1892.

With the ending of Parliament there is, of course, an ending of the provisional orders that will be confirmed this year, but fairly good progress has been made, and a number of provisional orders have been confirmed, as may be surmised when we state that there are no less than six electric lighting orders confirmation Bills. Those six Bills deal with the following:

Bill 1. Govan Electric Lighting Order, 1892, the undertakers being the Commissioners of Police and the Borough of Govan, the area of supply being the borough of Govan.

Bill No. 2 confirms the Aberystwith order, promoted by the Corporation of Aberystwith, the area of supply being the municipal borough. Ashton-under-Lyne, promoted by the Corporation, for the supply of the borough. Halifax, promoted by the Corporation, for the supply of the borough. Similarly, Harwich, Limerick, and Maidstone.

Bill No. 3 deals with Kilkenny, promoted by the Corporation of Kilkenny, for the supply of the borough. Also Newbury, promoted by the Corporation, for the supply of the borough. Sutton (Surrey), the undertakers being the Local Board, and the area of supply being the urban sanitary district of Sutton. West Ham, by the Corporation, for the supply of the county borough of West Ham. Woking, promoted by the Woking Electric Supply Company, the area of supply being a portion of the parish of Horsell and a portion of the parish of Chertsey.

Bill No. 4. Dublin, promoted by the Corporation, for the supply of the city. Fareham, by the Fareham Electric Lighting Company, for the supply of the district of the Fareham Urban Sanitary Authority. Liverpool, by the Liverpool Electric Supply, the area being a portion of the city. Oxford, authorising the transfer to the Oxford Electric Company. Sheffield, by the Sheffield Electric Light and Power Company, for the supply of the borough. Waterford, by the Corporation, for the supply of the borough.

Bill No. 5 confirms various undertakings promoted by the County of London Electric Lighting Company. The undertakings refer to the County of London work, the area being the united parishes of St. James's and St. John's, Clerkenwell, and the parish of St. Luke's, Middlesex; Southwark, the area of supply being the parish of St. George the Martyr, Southwark; Wandsworth, the area being that of the Wandsworth District Board of Works.

Bill No. 6 confirms the Hampstead order, undertaken by the Vestry of St. John's, Hampstead. Lambeth, also undertaken by the Vestry, to supply the parish. Shoreditch, undertaken by the Vestry, for supplying the parish of St. Leonard, Shoreditch. Whitechapel, undertaken by the Whitechapel District Board of Works, to supply the district.

THE VARLEY TESTIMONIAL.

A meeting was held at the Westminster Palace Hotel on the 1st July for the purpose of discussing the subject of the Varley testimonial. A considerable number of gentlemen were present, including Lord Kelvin, Major Flood Page, Mr. A. Siemens, Profs. Hughes, Perry, Silvanus Thompson, Forbes, Messrs. Gatehouse, Crompton, Stroh, Gorman, and others. Lord Kelvin took the chair.

A number of letters were read from gentlemen who were unable to attend, but who had signified their hearty assent with the objects of the meeting. Among these were Sir F. Bramwell, Sir H. Mance, Sir Leppoc Cappel, Sir D. Galton, Sir J. Pender, W. H. Preece, Prof. Ayrton, Prof. Kennedy, Dr. Gladstone, Prof. Lodge, Prof. Fitzgerald, Messrs. J. W. Swan, Belshaw, J. E. H. Gordon, Manville, Massey, R. K. Gray, Jackson, and Goolden.

Mr. Gatehouse then gave a very interesting account of Mr. Varley's life, and the services that he has rendered to electrical engineering.

After some remarks by **Mr. Crompton, Major Flood Page,** and **Mr. Siemens**, the following resolution was put and carried:

"That this meeting approves of a testimonial being got up on behalf of Mr. S. Varley, that the whole of these gentlemen who have given their names as willing to serve on the committee be and are hereby appointed a committee to act in the question of the Varley testimonial, and that an executive committee be hereby appointed, consisting of Lord Kelvin, Prof. S. Thompson, Prof. Perry, Mr. A. Siemens, and the gentlemen who attended the preliminary meeting."

Among other matters it was suggested that the aid of the Insti

tution of Electrical Engineers be sought to ask that the Government should grant a pension to Mr. Varley, and, further, that a statement setting forth what Mr. Varley has done should be prepared by Messrs. Siemens, Gatehouse, Silvanus Thompson, and Crompton, and this statement should be circulated as widely as possible among members of the electrical profession at home and abroad. That the general committee should consist of the names of the gentlemen who had attended the preliminary meeting, also those who had attended that day, and all the gentlemen who had written expressing their sympathy with the objects of the meeting, and that every effort should be made to extend the list.

LEGAL INTELLIGENCE.

H. F. JOEL AND CO. v. BARNET LOCAL BOARD.

The award in the arbitration between Messrs. H F Joel and Co., of 31, Wilson-street, London, and the Barnet Local Board, in which Messrs. Joel claimed compensation for breach of contract, was taken up by Messrs. Joel and Co. on Friday last, June 30, and was entirely in favour of Messrs. Joel and Co., who obtain £500 as damages, and their costs in the reference, and the costs of the award.

The arbitration proceedings were taken by Messrs. Joel and Co. for certain alleged breaches of the contract between themselves and the Barnet Local Board. Messrs. Joel undertook, under somewhat exceptional circumstances, to light the streets of Barnet with electric light for three years, at a cost, light for light, less than had been paid for gas, and, owing to the very short time allowed to do the work, they undertook to fix temporary plant and overhead wires, to be replaced within 12 months by permanent plant and underground wires, the consideration being that the Barnet Local Board were to give them the sole right to supply the private lighting for the three years, and a perpetual but not a sole right thereafter to continue so to supply the private lighting. The Barnet Local Board undertook to consent to Messrs. Joel having a license or provisional order, if necessary, to carry out the lighting. Messrs. Joel fitted the street lamps in an exceptionally short time, and started the light on September 1st, 1888, as agreed, but when, in the following April, the Local Board were asked to give their consent to the application to the Board of Trade for a license they refused their consent, although just previously they had been urging Messrs. Joel to take the license, and had actually agreed and did call a meeting to give such consent. This refusal completely stopped Messrs. Joel putting their wires underground, and of course they were unable to supply the private customers. The overhead wiring was not intended to be other than temporary, but it had to stand for the three years of the contract, and in the first two months of the lighting was the cause of several failures, which were much advertised to the prejudice of Messrs. Joel and Co. Messrs. Joel and Co. contended that such refusal of the Board to carry out the terms of the contract was a breach of that contract, and towards the end of the three years commenced the arbitration, with the result as first stated. Messrs. Joel and Co. completed their part of the contract to light for three years, in spite of the difficulties and opposition thrown in their way.

Mr. John Fell was the arbitrator for Mr. Joel, and Mr. Slater for the Barnet Local Board, whilst Mr. Lumley Smith, Q.C., was the umpire. Messrs. Ingeldew Ince and Colt, representing Mr. Joel, instructed Mr. Robson, Q.C., and Mr. Poole, the solicitor to the Barnet Local Board, instructed Mr. Fletcher Moulton, Q.C., and Mr. Gordon. The arbitration proceedings occupied many days, and many witnesses were examined, amongst them being the following electrical engineers—Mr. Preece, Mr. Probert, Mr. Howard Swan, Mr. Potter, Mr. Sennett, and most of the members of the Local Board

We understand Messrs. Joel and Co., immediately after taking up the award on June 30, gave the formal notice to the Barnet Local Board of their intention to apply in the forthcoming session for a provisional order under the Electric Lighting Acts of 1882 and 1888.

Mr. Preece's evidence was to the effect that on the two occasions upon which he saw the electric light at Barnet "the lighting was everything that could be desired"

NEW COMPANIES REGISTERED.

Electric Lamp Company, Limited.—Registered by H. W. Christmas, 42, Bloomsbury-square, with a capital of £4,000, in £1 shares. Object: to carry on business as manufacturers of electric lamps and electric apparatus generally. Registered without special articles

London Electric Manufacturing Company, Limited.—Registered by S. Morse, 4, Fenchurch-avenue, E.C., with a capital of £10,000 in £1 shares. Object sufficiently indicated by the title. With slight modifications, the regulations contained in Table A apply.

New Firm.—We understand that Messrs. Fowler and Gate have established themselves as electrical engineers at 20, Bucklersbury, and intend to pay special attention to the requirements of wiring and fitting interiors, especially in the City. Both Messrs. Fowler and Gate have had long experience with the Brush Company, and should thoroughly understand the work they will be called upon to do.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—The receipts for the week ended July 1 were £2,701.

Telegraph Construction and Maintenance Company.—An interim distribution of 12s. per share is announced.

Eastern Extension Telegraph Company.—The receipts for June amounted to £41,738, as against £39,749 in the corresponding period, showing an increase of £1,989.

City and South London Railway.—The receipts for the week ending July 3 were £763, against £719 for the same period of last year, or an increase of £44 The total receipts to date from January 1, 1892, show an increase of £1,293, as compared with last year.

London County Council.—Notices of mains to be laid and connections to be made, in accordance with rules and regulations, were before the Council on Tuesday from the Electricity Supply Company (mains across Panton street and on west side Oxendon-street and across that street to Prince of Wales Theatre); St. James and Pall Mall (various service lines); Kensington and Knightsbridge (service lines); House to House (service lines); Notting Hill (service lines); and Westminster Electric (service lines).

London Chamber of Commerce.—Notice is given that a meeting of the Electrical Trade Section will be held at the offices on Friday, the 8th inst., at 3.30 p.m., to consider the appended agenda, when a full attendance is particularly requested. Agenda.—(1) Minutes; (2) report of special committee appointed to consider the County Council by laws on overhead wires; (3) report as to the action taken by the special electrical traction committee; (4) report of the special Chicago Exhibition committee; (5) standardising of machinery; (6) uniformity of prices; (7) foreign competition; (8) other matters.

Pacific Cable.—Says *Trade and Finance*: "A very interesting registration at Somerset House last week was the Pacific and European Telegraphic Company, Limited, formed under the auspices of Sir John Pender and Sir James Anderson, to carry into effect an agreement between the Brazilian Submarine, Western and Brazilian West Coast of America, and the new company for the construction and maintenance of telegraphic communication between Buenos Ayres, Valparaiso, and Santiago." If there is to be another company, it will be wise to see that the "pickings" are somewhat less than they were out of the "Metropolitan."

Electric Organ Company.—An attempt is being made to promote a company called the Hope Jones Electric Organ Company, with a capital of £25,000 in 1,200 cumulative preference shares of £10 each, and 1,300 ordinary shares of £10 each. The patents to be acquired are No. 15,461 of 1890, and 18,803 of 1890. The payment for these is £3,000 cash, and 1,300 fully paid up ordinary shares. The Directors are of opinion that the balance of the issue of 1,000 cumulative shares—viz., £7,000—will be enough working capital. Far be it from us to stop investors, but we have not much faith in the future prosperity of a company when £13,000 of share capital and £3,000 in cash is given for patents for the application of electricity to organ work. The scope of the Company cannot be very wide; but organ-building is not exactly in our line, and the Company appeals more to the musical than to the electrical world.

Edison and Swan Electric Company.—At the Board meeting on Tuesday it was resolved: "That, subject to audit, the shareholders be recommended to declare a dividend on the A shares of the Company of 5s. 8¾d. per share on the 89,261 ordinary shares, £3 paid; of 9s. 6¼d. per share on the 5,000 £5 fully paid shares allotted to the Edison Electric Light Company, Limited; and of 8s. 10¾d. per share on the 12,139 £5 fully paid shares allotted to the Swan United Electric Light Company, Limited, free of income tax, being, with the interim dividend paid on the 22nd February, 1892, 7 per cent. in respect of the year ending 30th June, 1892; 7 per cent. in payment of arrears of cumulative preferential dividend for the year ending 30th June, 1887; and of 4 per cent. in respect of the year ending 30th June, 1888; all to be distributed in accordance with the provisions of clause 87 of the articles of association."

National Telephone Company.—The report for the year ending April 30 states that the income amounted to £463,741, as compared with £431,112. The working expenses and other charges (excluding debenture and other interest) amounted to £236,252, an increase of £38,768. The net result for the year, after deducting the Post Office royalties, amounting to £40,239, is a profit of £187,249, a decrease of £7,797. It must, however, be remembered that at the end of 1890, in view of the expiration of important patents, a reduction of the tariffs in most of the Company's districts was carried into effect. Upon the business of the past year, this reduction has been equivalent to a cession of about £55,000 to the subscribers. Further attention may be called to the fact that the rentals carried forward this year for unexpired terms of running contracts amount to £234,370, an increase of £29,938. Out of the divisible balance, after providing for interest on debenture stock, an interim dividend for the first half-year has already been paid at the rate of 6 per cent. per annum on the first and second preference shares, and 5 per cent. per annum on the ordinary shares. The Board recommend a further dividend for the last half-year at the rate of 6 per cent. per annum on the first and second preference shares, and 7 per cent. per annum on the ordinary shares, making, with the interim dividend, 6 per cent. for the year. They propose to transfer to reserve account £10,000, which, with £1,127 placed to reserve during the year from premium account, will bring up the amount of the reserve fund to £194,627.

PROVISIONAL PATENTS, 1892.

JUNE 20.

11487. **An apparatus for erecting top and middle sections of telephones and other poles.** Robert Frederic Jeffries, 26, High street, Wimbledon, London.

11525. **Apparatus for use in manufacturing electric cables.** George Gatton Melhuish Hardingham, 191, Fleet street, London. (Felten and Guilleaume, Germany.)

11526. **Improvements in electric cables.** George Gatton Melhuish Hardingham, 191, Fleet street, London. (Felten and Guilleaume, Germany.)

11528. **Improvements in dynamo-electric machines and motors.** Johannes August Carl Ziegler, William Rupert Rutledge, and Francis Erskine Allan, 70, Chancery lane, London.

11532. **Improvements in secondary or storage batteries.** Wilhelm Alexander Boese, 6, Lord street, Liverpool.

JUNE 21.

11548. **Improvements in connection with lubricators used on dynamo-electric and similar machinery.** Charles Scott Snell and Woodhouse and Rawson United, Limited, 88, Queen Victoria street, London.

11592. **Means for operating ammeters and other electrical apparatus.** Clyde Kennedy Mills, 23, Southampton buildings, Chancery lane, London. (Herbert Morris Pilkington and Roger Sherman White, United States.)

11617. **Improvements in or relating to dynamo machines.** Charles James Hall, 433, Strand, London.

11624. **Improvements in coin-operated telephone apparatus.** Henry Harris Lake, 45, Southampton buildings, Chancery lane, London. (Eloy Noriega, Mexico.)

11634. **Improvements in or relating to electric railways.** Frank Wynne, 46, Lincoln's-inn-fields, London.

11640. **Improvements in electric meters.** Francis Henry Nalder, Herbert Nalder, Charles William Scott Crawley, and Alfred Soames, 24, Southampton buildings, Chancery lane, London.

JUNE 22.

11664. **Improvements connected with tubular electric conductors and their insulation.** Ernest Payne, 39, Victoria street, Westminster, London.

11672. **Improvements in armatures for alternate-current dynamo-electric machines and motors.** Rookes Evelyn Bell Crompton and Sydney Linton Brunton, 53, Chancery lane, London.

11692. **Improvements in electric locomotives.** Frederick Purdon, Harry Ernest Walters, Basil Mott, and John Patrick O'Donnell, 2, Great George street, Westminster, London. (Complete specification.)

11698. **Improvements in insulators for overhead and other electric wires.** Fritz Meyer, 18, Buckingham street, Strand, London. (Complete specification.)

JUNE 23.

11735. **Improvements in and connected with electric dynamo machines distribution by means of transformers, organs, and the reduction of zinc.** James Swinburne, Broom Hall Works, Teddington.

11779. **Improvements in the manufacture of carbons for electric arc lamps.** George Frederick Redfern, 4, South street, Finsbury, London. (Carl Braun, Germany.) (Complete specification.)

JUNE 24.

11807. **Improvements in and relating to the measuring of electricity, and in meters therefor.** Rankin Kennedy, 96, Buchanan street, Glasgow.

11822. **Improved means for electrically winding up the weight for driving clockwork and other mechanism.** Hermann Aron, 6, Lord street, Liverpool.

11823. **Improvements in apparatus for measuring electric currents.** Hermann Aron, 6, Lord street, Liverpool.

11835. **Improvements in the process and apparatus for tanning hides and skins with electrolytic action.** Etienne Jean Finot, 28, Southampton buildings, Chancery lane, London.

JUNE 25.

11849. **Improvements in distribution and branch boxes for electric circuits.** Sigmund Bergmann, 70, Wellington-street, Glasgow. (Complete specification.)

JUNE 27.

11941. **Improvements in electricity meters.** Herbert Woodville Maher, 2, York mansions, Earl's Court, London. (Complete specification.)

11948. **Improvements in electric fire alarm and circuit controlling thermostat and clock mechanism.** Harvey Cortland, 52, Chancery lane, London. (Complete specification.)

11962. **Improvements in electric meters.** John William Jones, 13, Dornton road, Balham.

JUNE 28.

11969. **Telegraphic including telephonic communication between lightships and the shore.** Joseph Henry Hirst, 77, Bettingham street, Kingston upon Hull.

12039. **Improvements in the construction of electric railways and appliances therefor.** Thomas Floyd, 11, Furnival-street, London.

12040. **Improvements in and connected with arc electric lamps.** James Eglington Anderson Gwynne, 11, Furnival-street, London.

12044. **Automatic supply of electricity.** George Horatio Jones, 57, Great Russell street, Bloomsbury, London.

12057. **Improvements in printing telegraphs.** Samuel Rush Linville, 323, High Holborn, London. (Complete specification.)

JUNE 29.

12087. **Improvements in electric heating devices and contacts for the same.** Friedrich Wilhelm Schindler-Jenny, 8, Quality court, Chancery lane, London.

JUNE 30.

12191. **Improvements in electric railways.** Benjamin Joseph Barnard Mills, 23, Southampton buildings, Chancery lane, London. (Edward Hibberd Johnson, United States.) (Complete specification.)

JULY 1.

12212. **Electric regulating apparatus.** Julien May Bradford, 6, Monroe place, Portland, Maine, U.S.A.

12238. **Improvements in and apparatus for producing and utilising electric currents.** Bernhard Scarr-Drauer, 33, Chancery lane, London. (Complete specification.)

12246. **Improvements in electrical meters.** Yvan Arthur Marie Prosper Goulaux, 23, Southampton buildings, Chancery lane, London.

12258. **Improved electric glow lamp.** Paul Scharf, 28, Southampton buildings, Chancery lane, London.

JULY 2.

12295. **Improvements in electric arc lamps.** William Habgood, 19, Chandos road, Buckingham.

12306. **Improvements in the construction of secondary batteries for electrical storage purposes.** John Bridges Lee, 3, Brick court, Temple, London. (Complete specification.)

12311. **Improvements in electric theft-prevention alarms.** Charles Darrah, of the firm of Baxendale and Co., and Thomas Joseph Gough, 70, Market street, Manchester.

SPECIFICATIONS PUBLISHED.

1886.

14105. **Electric signalling for railways.** Walker. (Second edition.)

1891.

7781. **Converting electric currents.** Boucherot.
11113. **Electromotors, etc.** Lahmeyer.
12525. **Electrical steering gear.** Grimston and Dykes.
13124. **Heating and welding by electricity.** Howard.
13250. **Electrical switches.** Wheatley. (Andalek.)
13252. **Electrical contact making and breaking devices.** Fox and Ducretet.
13331. **Telephony.** Kellogg.
13367. **Electric telephone switches, etc.** Sloper.
13802. **Electric current generator.** Sohlman.
13927. **Printing telegraphs.** Van Hoevenbergh.
14500. **Electrical transmission of power.** Muir. (Leonard.)
19495. **Electrical conduits, etc.** Powers and Van Buren.

1892.

2055. **Closing electric circuits.** Wise. (Bertolini.)
5034. **Electrically controlled elevators.** Johnson. (Hiss.)
6181. **Electric fire alarm.** Woolley.
6722. **Secondary batteries.** Donaldson and Macrae.
7415. **Electric propulsion of vehicles, etc.** Dewey.
8242. **Electrically propelled vehicles.** Hawkwander.
8535. **Electrical hose signalling apparatus.** Fowler.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	Price Wednesday
Brush Co.	—	[illegible]
— Pref.	—	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
House-to-House	5	[illegible]
Metropolitan Electric Supply	—	[illegible]
London Electric Supply	[illegible]	[illegible]
Swan United	[illegible]	[illegible]
St. James	—	[illegible]
National Telephone	5	[illegible]
Electric Construction	10	[illegible]
Westminster Electric	—	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]

NOTES.

Gravesend is to have a new technical school.

Poole.—The electric light is installed throughout the new town offices at Poole.

La Charente.—The docks at La Charente, France, are to be lighted by electricity.

Lewisham is to have a new infirmary, and will probably adopt the electric light.

Zurich.—A company has been formed in Zurich for the purpose of establishing central stations in that town.

Glasgow.—Mr. John Young has been appointed general manager of the Glasgow tramways, at a salary of £1,250 a year.

Electric Harpoon.—The idea has again arisen of electrically attaching the harpoon to an alternating current, and thus to shock the whale.

Honolulu Cable.—The survey for the cable between San Francisco and Sandwich Islands has been completed. The length from Hilo is 2,060 miles.

Berwick.—The Berwick Town Council have appointed Mr. C. R. Templeton, of Gateshead, consulting engineer, to draw up a plan for lighting by electricity.

Niagara.—It is stated that 50,000 h.p. will be ready for use in October at Niagara, and that dynamos for 10,000 h.p. for transmission have been ordered.

Barnsley.—The proposal to establish a central station, at a cost of £18,382, and to apply for sanction to borrow the money, will come up at the next meeting of the Council.

Islington. — Extensive premises at Islington and Willesden Green are advertised in the daily press suitable for electric light purposes by Segrave and Taylor, 117, Holborn.

Brake Blocks.—In electric, as well as tram and other railways, brake blocks are used. We notice that lignum vitæ is being used for this purpose with good results in lasting power.

Sevenoaks.—A letter was received and read at the last meeting of the Sevenoaks Local Board from the Board of Trade, enclosing notice of revocation of the electric lighting order.

Glasgow.—The new Municipal Buildings have cost a total of £529,909. 7s. 8d. Of this the electric installation cost £2,209. 12s. 8d., and the electric and gas light fittings £4,008. 7s. 8d.

Tariff.—E. Dieudonné has an article which may interest central station managers in *L'Electricien* for July 9, on how the tariff for current should be regulated upon the demand and other data.

Fulham.—The Fulham Vestry is of opinion that a polytechnic institute should be erected in the parish, and have appointed a committee to carry out the resolution embodying this opinion.

Electric Power Storage.—Electrical engineers will be pleased to see the good business that is being done by the E.P.S. Company, whose gross profit of £37,000 odd allows a dividend of 6 per cent.

Electric Crane at Woolwich.—The General Electric Power and Traction Company, Limited, have received instructions from the War Office to erect a five-ton electric travelling crane at Woolwich Arsenal.

The Elections.—The electric light signals of the election results shown at the National Liberal Club were on the Roman letter system of Mr. C. E. Kelway. An effective illustration of the scene appears in this week's *Black and White*.

Colliery Work.—The General Electric Power and Traction Company, Limited, have added another dynamo to the extensive plant at Messrs. Locks and Co.'s St. John's Colliery, Normanton. The machine was started on Saturday last.

Colliery Lighting.—The General Electric Power and Traction Company, Limited, have received instructions to light the New Hemsworth Colliery, near Halifax. The plant consists of a 300-light dynamo, and the necessary wiring and fittings.

Belgium.—A project is being mooted to change all the smaller branch railways in Belgium—*chemins de fer vicinales*—from steam to electric traction. Such a project, if carried out, will give a great impetus to the extension of electric railways.

Guildford.—There seems to be a desire among the members of the Council to push forward the question of electric lighting. At the last meeting it was decided that Mr. Shoolbred's report should be printed and circulated among the members.

Liege.—An electric street railway, belonging to the Tramways Company of Liège, is being built by the Compagnie Internationale d'Electricité of Liège, and will be opened in October. There will be two compound-wound dynamos as generators.

Burnley.—The Board of Trade has extended by six months the time allowed in which to put down the electric lighting installation. There seems to be no reason now why specifications should not be got out at once, tenders obtained, and operations commenced.

Edinburgh.—At the meeting of the Council on Wednesday, a letter was submitted from Mr. Holroyd Smith, inviting a deputation of the Council to Bradford to inspect the electric tramway there. The subject is to be dealt with by the Lord Provost's Committee.

"Electrical World."—We were pleased to welcome to England last week Mr. W. J. Johnston, the genial proprietor of the *Electrical World* of New York. Mr. Johnston usually makes a trip to Europe every two years, and this time is accompanied by his wife and children.

Explosion.—Another explosion, seemingly attributable to gas leakage, took place on Saturday last week, this time at Bournemouth. The damage was slight, and the fact that the fuses were not melted made it evident there had been no short-circuit. A strong smell of gas had been previously noted.

Paddington.—The Metropolitan Electric Supply Company has written to the Paddington Vestry on the subject of their accounts. After Colonel Blair had expressed his opinion that the company were trying to wriggle out of their contract with the Vestry, the matter was referred to him and to Colonel Blanchard to deal with and to act.

Leith.—At the meeting of the Dock Commission a report was submitted regarding the proposal to introduce the electric light at the docks. It was estimated that the installation would cost £10,000, and that the annual cost, including depreciation of plant, would be £2,300. The report was remitted to the Works Committee with powers.

Newcastle-on-Tyne.—Tenders are required by July 19 for the electrical lighting of the whole of the warehouses and offices, Newcastle-upon-Tyne, for the Committee of the Co-operative Wholesale Society, Limited. Information can be obtained from the society's engineer, Mr. John Thompson, C.E., Post Office-chambers, Newcastle-upon-Tyne.

Claybury Asylum.—The Asylums Committee of the London County Council reported, at the Tuesday's meeting, recommending that they should be authorised to accept tenders for electric lighting of Claybury, and additions to Banstead and Cane Hill Asylums during the recess. This was agreed to. Tenders are to be sent in by July 26th.

Crystal Palace Awards.—We understand that considerable dissatisfaction is found in the method, manner, and result of the giving of awards at the Crystal Palace Exhibition. Some of the exhibitors say that the puzzle has been even to find the jurors, and, in fact, though they have been hunting after them for weeks, they were never able to find any of them.

Epstein Accumulators.—That these are making steady progress is evinced by the fact that the Birmingham Central Tramways Company have just placed an order for 600 Epstein cells with the Midlands branch of Messrs. Woodhouse and Rawson United, Limited, at the Minories, Birmingham, the cells being for use upon their important electric car route in that city.

Vaultage.—Heard in the City:—First Man: "They'll soon have the full number of 2,000 volts on the City electric lighting mains, they say." Second Man: "Ah, so many; well, I don't wonder: they've put one vault opposite my place for the wires, and a fine old mess, too. I shouldn't wonder if there were 2,000 of em scattered about. I suppose that's where they store it."

Weymouth.—An application was read at the Weymouth Town Council last week from the secretary of the Aurora Electric Lighting and Distribution Company, asking for the consent of the Urban Sanitary Authority to an application they propose to make for a provisional order to supply the town with electric lighting, and for other purposes. The application was not entertained.

Brillie Meter.—An order has just been received by the Compagnie Anonyme Continentale of Paris for a Brillié meter, fitted with diagram recorder, for 2,000 volts up to 30 amperes alternating current, for the Chelmsford central station. As the same company last year made a meter for 2,000 amperes and 100 volts, they claim to have constructed the two largest meters yet put in action.

Oxford.—At last week's Oxford City Council a letter was read from the secretary of the Ashmolean Society, in reference to the co-operation of the Council in giving an invitation to the British Association to hold its meeting in Oxford in 1894. After a short discussion, it was resolved that the Mayor, Colonel Swinhoe, and the town clerk should form a deputation to give such invitation to the association.

Personal.—Mr W. J. Hammer, who has for some time past been on this side as representative of various American electrical interests, returned to America on the s.s. "Majestic" on Wednesday last, owing to important business matters necessitating his presence on the other side. Mr. Hammer expects to return to England again in a short time, and meanwhile all communications should be addressed to Temple-court, Room 533, New York.

Tercentenary Celebration at Dublin.—Amongst the distinguished representatives of science, literature, and art who have attended the Trinity College tercentenary, Dublin, were the following well-known electrical names: Lord and Lady Kelvin, Lord Armstrong, Sir F. Bramwell, and Profs. Ayrton and Perry. Amongst those who have received honorary degrees, it is interesting to note the name of Mr. Henry Irving, who has received the distinction of Doctor of Laws.

City Lighting.—The Board of the City of London Electric Lighting Company, Limited, give notice that the supply of current will be available, both day and night, on and after the 1st August. Colonel Haywood, at the Commissioners of Sewers meeting, in answer to a question, stated that the mains were laid in nearly every chief thoroughfare and some others. Mr. Johnson thought the work in the City was about half done. A plan was kept which could be inspected by the members.

Whitby.—At the last meeting of the Local Board Mr. Brown said he was informed that they some time since spent £412 in obtaining an electric lighting order, and he thought that some use should be made of it. He moved that the Electric Lighting Committee be requested to take steps to consider the desirability of applying the order in Whitby. They were paying £1,000 a year for gas, and this order had cost them £412. What were they going to show for it? Mr. Raine seconded the motion, which was carried, and Mr. Brown was added to the committee.

Lane Fox Patents.—Before the Privy Council on July 7, the petition by Mr. Lane Fox for prolongation of patent was dismissed. Lord Hobhouse pointed out that before there could be a prolongation of a patent the Judicial Committee must report to her Majesty that the patentee had not been adequately remunerated. It was the rule that full accounts must be laid before the Attorney-General, and afterwards before the Judicial Committee. The petitioner submitted that the accounts in this case were as full as possible. After some discussion their Lordships dismissed the petition on the ground that the accounts were insufficient, and, on the application of Mr. Wallace, they granted one set of costs.

Rockhampton, Queensland.—The secretary of the Rockhampton Gas Company writes that we were too previous in the statement in our issue of April 22, reporting the acceptance by the municipality of the offer of a Sydney firm for electric lighting. The gas company has secured the right by Act of Parliament to supply the town with electricity, and has submitted proposals to the Town Council with this end in view. The company has erected a central station, which, with necessary plant, will cost about £10,000. Bravo! gas company. On May 31st, according to an official letter of the town clerk, now before us, the Council has not decided about the offer of the gas company, but, of course, would not entertain any other offer till that was disposed of.

Cranes at Chicago.—Four of the principal makers of travelling cranes are to place cranes at the Chicago Exhibition, in such a manner that passengers can be carried over Machinery Hall and obtain a bird's-eye view of the exhibit. The length of course run by each crane will be 1,400ft., and the cranes will all be operated by electricity, and travel at the rate of 300ft. to 500ft. per minute, if the latter speed is required. The purpose of these cranes is not entirely for the pleasure of visitors, as they will be erected in the autumn of this year and used in placing the exhibits. The trolleys will then be removed from the cranes while they are in use for passengers, and after the conclusion of the exhibition the exhibits will be removed by the help of these same cranes.

Popularising Electrical Knowledge.—It is singular how little real knowledge about electrical matters has as yet diffused among the public, hence we welcome all such popular expositions as that of Mr. A. Fahie in *Health Record*. One of his points is directed against cheap fittings for electric light purposes. "Cheap and nasty" is proverbial, but it is extremely difficult to counteract the buying of such materials. Increased knowledge

made by the returning officer at Ealing by the flashing of two of Ronald Scott's well-known search-lights of 30,000 c.p. each, was most successfully carried out in every detail. The two projectors were placed on the roof of The Elms, Mr. Scott's residence at Acton Hill, which is at about the same level as St. Paul's. Before the returning officer had finished his announcement both beams of light were sweeping the country round. One search-light was then manipulated to signal the actual figures into Acton and on to Chiswick at the same time, the signalman at Chiswick being stationed at the top of the Fire Brigade tower, a distance of 2½ miles from the source of light. The majority was first signalled, and then the numbers polled by each candidate, but although accurately signalled and read, the signalman at Chiswick was so astounded at the enormous majority of Lord George Hamilton that he awaited confirmation by bicycle from Ealing before giving out the result. The time occupied in transmission was less than four minutes.

Electric Light in Ireland.—The editor of the *Waterford News*, in order to show Waterford what has been done elsewhere, has written to Dublin and Carlow to ask how the electric lighting is going on in those towns. The answers received are interesting. Mr. Spencer Harty, city surveyor, Dublin, says: "In reply to the queries relative to the electric lighting, I have to say that the present installation is confined to some of the leading thoroughfares of the city, and will not, at least for the present, be extended to the narrow thoroughfares. We have received a great number of applications for private lighting, and expect to have the full load of our plant in operation." Mr. James Kelly, town clerk of Carlow, says: "The electric light is going on very well here, and giving most general satisfaction. The narrow streets are lit with it. We have principally incandescent lamps in these streets, and arc lamps in the principal thoroughfares. As to the difference in the cost of this light and gas, I cannot well say, as Carlow was lighted by oil for the past 15 years. Shopkeepers are taking in the light every day. Our agreement with the contractors is for three years; but we have—so far only as we have lawful power and authority so to do, but no further or otherwise—conceded to them the sole right of public and private lighting of the town for the space of 21 years, but our contract for lighting is terminable after three years and may be renewed. We did not advertise for contractors; the firm sent in an estimate in November, 1890, which was accepted by the Commissioners without the advice or opinion of an independent engineer. We never had a printed report on the lighting, as it was not thought necessary."

Acton Hill Electrical Works.—The fourth annual sports of the Acton Hill Electrical Works were held on Saturday last, the 9th inst., in the grounds behind the works, by kind permission of Mr. Ronald Scott, the president. Everything passed off well, the occasion being enlivened by the large number of the fair sex present. The band of the 4th Volunteer Battalion East Surrey Regiment were on the ground, and played up to their usual standard of excellence. It was proved that the athletic element was not wanting in the works, Mr. E. H. Turrell and Mr. A. Patey showing themselves very fast at the 100 yards and ¼ mile respectively. Mr. H. Squire carried off the pole jump, long jump, high jump, putting the weight, and throwing the cricket ball in very fine form. There were two bicycle races, one for solid and one for pneumatic tyred machines, the former being won by Mr. B. Chilton, and the latter by Mr. G. Hickman. The competitions terminated with "walking the greasy pole" over a large pond in the grounds, which event caused, as may be imagined, great amusement, the flag being finally secured by Mr. G. Robarts. At the conclusion of the sports, Lady Nares very kindly distributed the prizes, an event which added greatly to the *éclat* of the proceedings. Mr. Ronald Scott afterwards moved and Captain Kay seconded a vote of thanks to Lady Nares, which was carried with acclamation. The visitors then paid a visit to the shops, and inspected the machinery in motion and work in course of erection, and were further interested in various electrical experiments. This brought the proceedings to a close after a very enjoyable afternoon. The sports were carried out under the able management of Mr. J. H. Garratt, assistant electrician to Mr. Scott.

Barnsley.—The chief interest at the last meeting of the Town Council centred in the electric lighting question raised on the report of the Park and Lighting Committee, which recommended: 1. That the electric light be installed on a site in Beckett-square, at an estimated cost of £18,382, but that at present only £13,332 be expended. 2. That Mr. A. Bromley Holmes be appointed electrical engineer, and that he be instructed to prepare all plans, specifications, and estimates of the electrical plant, and that the borough surveyor be instructed to prepare the plans, specifications, and estimates of the requisite buildings, and that such plans and estimates be submitted to the committee as early as practicable. 3. That application be made by the Council to the Local Government Board for their sanction to borrow the said sum of £18,382. These recommendations were based on a report made to the committee by the borough surveyor (Mr. J. H. Taylor) after a very full investigation of the subject by himself and the committee. In the report two schemes are submitted—the first for a nominal output of 2,500 8-c.p. lamps, and 28 1,200-c.p. arc lamps for street lighting, with 2 miles 93 yards of mains and feeders laid underground, and the second for a nominal output of 5,000 8-c.p. lamps, of 31 1,200 c.p. arc lamps, with 2½ miles of mains and feeders laid underground. The first scheme embraces Regent-street, part of Church-street, Market-hill, Peel-square, Eldon-street, Kendray-street, Mayday Green, Cheapside, Queen-street, part of Sheffield-road and Newland, a length of 1¾ mile; and the second adds Peel-street to the area, making 1⅞ mile; and with mains and feeders laid in Shambles-street. No. 1 scheme covers 45 and No. 2 ... acres, containing 11 houses of more than £20 a year rateable annual value; 252 shops, 11 mills, workshops, and chapels. Probably consumers for 2,500 8-c.p. lamps would be obtained in a year, especially as the Harvey Institute would require 1,000 such lights. Scheme No. 2 would cost £18,382, and if fully worked would yield a profit of £1,428. 18s. per year, half the number of lamps in use would give a profit of £181. 6s.

Accumulator Traction.—At the meeting of the London Tramways Company at Camberwell Green on Monday, Mr. David P. Sellar, the chairman, complained that the carrying power of the company had practically come to an end, at any rate until the cable was started. A large sum had been borrowed on debentures to pay for the alterations. It was impossible to carry passengers more cheaply than the company did. The number carried during the past half year was 33,700,000. This was considerably more than they carried in the financial year ended 11 years ago. The buildings at Streatham Hill were not completed. They hoped to have the cable in working order during the next two months, and that they would be able to show a good return for it at the next meeting. On Colonel Davidson seconding the adoption of the report, an amendment

was proposed for a committee to go into the financial position of the company. After some discussion the report and balance-sheet were adopted, the amendment finding no seconder. Mr. H. C. Clements then moved: "That the time has arrived when it will be much to the interest of the shareholders that there should be no unnecessary delay in substituting electric cars for horse cars, and that it was the wish of the shareholders that the directors should enter into an arrangement with an electric company for the alteration of the present cars into electric cars and the supply of the necessary electricity; or that they themselves should alter the existing cars into electric cars and provide the necessary electricity, and as quickly as the electric cars could be obtained and supplied with electricity they should be used upon the road." The chairman, in reply, made the statement that there was not a single accumulator tramway running—everywhere the system was a failure. Mr. Luther Clements seconded the motion, which was rejected. This instructive passage shows very forcibly both the desire of the shareholders to take up electric traction, and the necessity for the production of a reliable accumulator—accumulator cars being the only kind most companies desire. It is a pity the company, while altering their line, could not have introduced the slot system of electric cars, which have proved so successful in the hands of Messrs. Siemens at Budapest.

Forcing Vegetables by Electricity.—Electricity, a writer in the *Horticultural Times* tells us, is about to find full employment in horticulture. Spring vegetables are already being forced by its aid for the market. There is no doubt that roses and other flowers can be made to bloom more plentifully and more profitably with its assistance. In short, the discovery affords promise of possibilities not yet estimated. It has been found that lettuce is particularly susceptible to the influence of the electric light, by means of which it can be grown for market in two-thirds the usual length of time. Other vegetables respond likewise in varying degrees. But everything depends upon the proper regulating of the light, and how to do this can only be learned by careful study of the results produced under all sorts of conditions. The effects of electricity being to hasten maturity, too much of it causes lettuce to run to seed before the edible leaves are formed. It must not be imagined that electricity is employed for such purposes as a substitute for sunlight. It is merely used in a supplementary fashion. The greenhouse that has the sun in the daytime is illuminated at night with arc lights, toward which the plants incline their leaves and flowers, accepting quite innocently these artificial counterfeits of the orb of day. It was supposed hitherto that vegetables required intervals of darkness for their health and development, just as animals need sleep, but it has been shown that, supplied with electric rays, they will go on growing thriftily between sunset and daybreak; staying up all night seems to do them no harm so long as the dissipation is properly regulated. The electric gardener employs opal globes to diminish the intensity of the light. When it is left bare and admitted to shed its unfiltered rays upon the plants, the latter grow pale, run up quickly in sticky stalks, and soon die. It remains to be discovered exactly how much electricity is beneficial, and during precisely what period of the development it ought to be applied. The influence of electricity upon the colour and productiveness has been shown to be extraordinary. Tulips exposed to its light have deeper and richer tints, flowering more freely, and developing longer stems and bigger leaves. Fuchsias bloom earlier under like conditions. Petunias also bloom earlier and more profusely, growing taller and more slender. It is the same way with many other flowers. In fact, there is every reason for believing that the electric light will be very profitably used in future as an adjunct to forcing establishments for both flowers and garden vegetables.

The History of Telephone Enterprise in Belgium.— Mr. Conyngham Greene, of the British Legation in Brussels, has lately written a report on the history and progress of telephone enterprise in Belgium, from which it appears that up to 1883 the telephone service in that country was in the hands of private companies, and the uncertain character of the concessions granted by the State checked the free expansion of private enterprise. Between 1880 and 1883 three separate telephone systems were in operation in Brussels, but, owing to competition and the refusal of the companies which worked the lines to grant mutual subscriptions over the lines of their rivals, no great success was obtained by any of them. In 1883 the State Department of Posts and Telegraphs took the initiative in organising and developing the telephone system of the country. A law was then passed authorising the Government to undertake themselves, or to concede on fixed conditions to others, the establishment and development of telephone lines. The uncertain and temporary character of the previous concessions gave place to a certain and regular system, and the effect was immediate. In a few months the Bell Telephone Company bought up the two rival companies of Brussels, and secured a concession not only for the capital itself, but also for Ghent, Antwerp, Verviers, and Charleroi. The company started with a paid-up capital of £105,400, of which more than two-thirds was devoted to buying up the rival plant and apparatus, and replacing that which was worn out and inefficient. The existing wires were replaced by phosphor-bronze wires on the Montefiore system. Owing to the superior capability of this wire for bearing a strain, it was found possible to diminish the number of supports, and thus to get rid of much useless material. Moreover, the expense of repairing the wires was materially reduced as breakages were of very rare occurrence, and the interruption of the service proportionally unusual. By way of dividend the company distributed in 1889 among its shareholders £10,750, and £15,181 in the following year, while the number of subscribers rose from 4,051 on December 31, 1888, to 4,726 in 1892. The State has also laid and worked lines of its own to the less important centres, which were somewhat neglected by the companies. A system of receiving and transmitting telegrams by telephone to subscribers has been introduced and has proved a great success. At present the repurchase of all the telephone concessions by the State is impending, and will probably take effect from January 1 next, when a further large extension of the telephone system will take place. The Belgian experience is that the telegraph and the telephone do not injure each other, but that both systems must be in the same hands to enable the universal extension of the telephone system to pay. It appears, however, that in regard to Press messages between Paris and Brussels the telephone has wholly supplanted the telegraph, and the same is true to a large extent of Press messages generally. The head of the technical department of the Belgian telegraph and telephone services stated the principle of successful administration to Mr. Greene in these words: "The telegraph and telephone service must be one great monopoly, and that monopoly must be in the hands of the State."—*Times*.

COMING DEVELOPMENT IN ELECTRIC RAILWAYS.

BY FRANK J. SPRAGUE.

[This is the inaugural address to the American Institute of Electrical Engineers, and is well worth careful attention.]

It is a trite but mistaken saying that electricity is in its infancy. It dropped its swaddling clothes when Morse sent the first telegraphic message. It put aside dresses and pinafore when the dynamo and arc light were invented. The incandescent lamp, the telephone, the art of welding, the transformer, are incidents of buoyant youth. The modern electric motor and electric railway mark a vigorous manhood. The truly marvellous development of electric applications of every kind, the accomplishment of many things which in ignorance of the very art, or lack of knowledge of what are now well-known facts, and more particularly the great commercial development of the transmission of power, whether for stationary purposes or for electric railways, has led to many a foolish prediction and idle boast. This is no age of inspiration, nor time for hopes never to attain fruition. It is above all things a practical age, perhaps too practical, but, nevertheless, one in which commercial enterprise, to be successful, must promise either a new field of development or economise in older fields. As the orthodox few have been waiting in sublime faith for many centuries, and will wait for many more, for the fulfilment of ancient prophecies, so too will impracticable electric enthusiasts wait for the millennium when investments are boundless, performances limitless, and efficiences unity.

It would, perhaps, have been proper in making my inaugural address to so representative a body as that of the electrical engineers, that I should touch upon the special discoveries and experiments which have recently attracted attention, but there have been so many enthusiastic and brilliant workers that neither the time at my disposal nor the knowledge I possess would permit me to do justice to their work; hence, it seems better to take up a subject with which I have been more particularly identified, which to-day commands so much attention, and concerning which there are so many conflicting opinions. While finding encouragement in the past achievements of our profession, I think the time opportune for a word of caution.

Electric street railways are no longer experimental, nor is their success problematical. Their history for the past five years is that of an almost unequalled development. Almost within a decade has occurred the first working of a practical electrical railway. In a third of that period there have been put in operation or are under contract more than 450 roads, equipped with nearly 6,000 cars, over 10,000 motors, and with over 3,000 miles of track. There is made a daily mileage of not less than 700,000 miles, and over a billion passengers are carried annually. At least 75,000,000dols. have been invested in this industry alone. Thirty thousand horses in a single year have been relieved from the slavery of street car propulsion; stables are disappearing, and streets becoming cleaner; luxurious cars are running on smooth, well-built, and rigid road beds. Dividends have been increased, expenses reduced, investments enlarged, the unproductive have become productive, the impossible possible. Land values have been increased, habitable limits extended, homes created, and time saved. We no longer hear seriously of the dangers of the trolley wire, the failure of service. The time has come when legitimate investment is amply warranted. Electric street railway construction has become a matter of engineering, not experiment. Not only have the smaller towns adopted what is the only available means of current supply, but the larger cities are following their example. St. Louis and Baltimore, Minneapolis and St. Paul, Buffalo and Rochester, Boston and Brooklyn have fallen into line, and latterly even Philadelphia seeks an improved street service, and in New York public interest is being aroused. In the latter city it is, of course, impossible to tell how successful will be the attempt to introduce electric propulsion. There is there a strong, and in many respects a legitimate, objection to overhead wires. Many unsightly poles and badly-strung wires have disappeared, and their places are taken by an underground service.

The general feeling of opposition to poles and wires ought not, however, to act as a barrier to such reasonable and proper introduction of an overhead system of supply, as the conditions now existing in that city very properly warrant. I have frequently pointed out the fact that the greatest good can come of the greatest number, especially in the over-burdened condition of transit which there exists, if certain of the lines were electrically equipped; wherever, in fact, there would be no street obstruction. In broad streets, where the tracks occupy only a small portion of the street and are near together, a line of poles of ornate design, with arms projecting on either side, can follow the centre of the street, the same poles being used for lighting. Such a street, it seems to me, is Eighth-avenue. Then, too, where there is a middle division or park, such as exists in many boulevards, and which is now used for telegraph poles, there is opportunity for an electric construction which would be entirely unobjectionable. On streets occupied with elevated structures, these structures themselves could be used for a practically rigid overhead system.

Among the numerous places in New York where an overhead system could be put in perfect operation are Central Park, West, the boulevard from Fifty ninth-street, up, a part of the First and Second Avenue lines, the Third, Sixth, and Ninth Avenue lines, and all the suburban extensions from the annexed district. I am not sufficiently familiar with the streets of Chicago, which is the last other remaining city which must consider electric street railways. In these larger cities, however, one condition should be insisted upon, and if this condition is not in the proper spirit, then much of the objection which has been raised against an overhead system must necessarily disappear. The construction must be of the very best. The only overhead line allowed should be a contact wire with sufficient strength; the main conductors and the feeders should be put underground in proper conduits. There would then be overhead only a wire necessary for the smallest duty, and of the requisite strength.

Impressed by the great development of this industry, and brought face to face with the changes it has wrought, the query is continually made, Will the electric motor replace the steam locomotive? It is similar to the older questions: Will the telephone replace the telegraph? Will the electric light annihilate the gas system?; and in all soberness a like answer can be made. It will not, but it will, as the electric light, and as the telephone have done, create a field of its own, and will replace a portion of the service now done by steam. It seems to me that the growth of electric railways will proceed something in this order: First, the street systems in the various towns, then connecting lines between adjacent towns following the lines of highways, then longer connecting lines, even on the tracks of the existing steam lines, or growing bolder, on exclusive rights of way on the same order. Then will come suburban traffic on a larger scale, and freight transfer systems, and finally the more ambitious projects of trunk line service under limiting conditions, such as I will specify.

It has been very properly said that a man will make the first long rides on electric railways by transferring from one town system to another through connecting links, rather than on individual roads. This is precisely the process by which great steam systems have been built, although, of course, starting on a larger scale, and it is but natural that this shall be one step in the development of electric railways. But evidently this natural process of evolution does not offer scope enough for the more enthusiastic, and we are now and again treated to an ideal electric road to be built on plans boldly defying both geography and the abodes of civilisation. An air line route, according to rules of surveying, allowed only in Russia and on the desert of Sahara, abolition of grades and street crossings, rigid and continuous rails; loaded cars of light weight, each operated by its own motor, and making few or no stops, unlimited potentials and undiscovered resistance to insulation, new physiological and engineering laws; indestructible machinery; unheard of powers of braking and new methods of

train operation and signalling; around all, a clear atmosphere, above all a perpetually smiling heaven, and behind all an unlimited bank account and the unlimited confidence of the investor.

Such are some of the characteristics of such a road, but perhaps it is but fair to ask, given some of these conditions, what would be the capacity of steam traction? No one will question the capacity of a motor to do the necessary work required, or to make a speed superior to that of the steam locomotive provided sufficient energy be delivered to its terminals, but we must deal with existing or probable methods of supply. It is true that the speed at which a train is propelled by steam has only increased about 50 per cent. in 60 years, for in 1832 the "Matthew Baldwin" often made a speed of a mile in a minute; but we must not confound speed with power, for while the maximum speed has not been so materially increased, the endurance, the perfection of the mechanism, and the economy of performance have made great strides. The increased speed, which is by no means the maximum possible of a locomotive, *per se*, has been attained at much higher powers, and the schedule time has been shortened principally by cutting down grades, straightening curves, filling up ravines, abolishing trestle works, replacing wooden bridges by permanent ones of iron or stone; by the use of heavier and stiffer rails, better switches, improved methods of automatic signalling, the interlocking switch and signal system, and the abolition of grade crossing; in shops, by improvements in details and management which permit of higher speeds on more extended sections of road because of greater safety, lower traction coefficients, and a greater degree of confidence possessed by the engineer. All these things are necessary for high-speed electric railways, and any general improvements that will be of benefit to the latter must necessarily be of service to the former. Many predictions which are made concerning the future of electric propulsion, either in ignorance or disregard of the possibilities of steam duty, and the limitations necessarily existing in all systems of transportation, deserve and will receive little consideration. Hence, let us note a few of recent locomotive performances.

Almost everyone is familiar with the remarkable run recently made by a Schenectady locomotive hauling a special train on the New York Central Railroad, when the distance of 439½ miles from New York to Buffalo was made at an average speed of nearly 60 miles per hour, and which was the precursor of the Empire State Express, which makes the regular run at an average speed of over 52 miles.

More recently, we have accounts of an interesting record made by a well known writer on two runs between New York and Albany, on which a large number of indicator cards were taken. The weight of train was about 270 tons. The steam pressure varied from 160lb. to 170lb. From an inspection of about a dozen cards, the indicated horse-power varied from 551 h.p. at 41 miles to 1,120 h.p. at 78.9 miles. At 60 miles per hour the train resistance is stated to have been 15lb. per ton, and at 70 miles 17·10lb. per ton. About 7lb. of water were evaporated per pound of coal. A remarkable statement concerning this performance was made by Mr. Sinclair, which, while almost incredible, will, if borne out by an analysis of facts, prove to be something of a surprise to those who make their prophecies of the electric economies by comparative statements. In the description of these tests in a recent number of "Locomotive Engineering," it is stated that the whole trip shows an indicated horse-power per hour for an average expenditure of only about 3½lb. of coal per hour. This is far better than any stationary engines.

On the New Jersey Central Road, one schedule time is 86½ miles in 89 minutes, which is made when there are a number of necessary slackings. On the 13th of May, the time was taken of the speed of a Baldwin compound locomotive for a considerable period of time on one of the regular runs. Ten continuous miles were made in 452½ seconds, and five were made in 222 seconds. The fastest time taken was 44 seconds, and the slowest made was 47. On the 26th of last February a similar compound passenger locomotive running on the same road, broke all steam records by running a mile in 39½ seconds, or at the rate of nearly 92 miles per hour. At this speed the indicator cards showed 930 h.p., and the drivers, which are 78in. diameter, were making 395 revolutions per minute.

In the very near future I expect to have the pleasure of riding on a locomotive when going on these high speeds, and I presume my respect for steam locomotion will not be diminished thereby, nor, on the other hand, will my confidence in the possibilities of electric propulsion under the proper conditions. Experimental runs have been made with an electric locomotive at the rate of a mile in 30 seconds—that is, 120 miles an hour, and I confidently expect some day to go at that rate; but it will be under special conditions, and not on the regular trunk lines of this country, and it is the height of folly to suggest that these steam trunk lines are to be abolished. In making these very high speed runs there is not much attempt at maximum economy of coal consumption, the necessity being to generate steam as fast as required by the cylinders, but on taking an average of five trips, I find that there was evaporated 7·19lb. of water per pound of coal used, and 9·41lb. of water evaporated per pound of coal consumed. The total weight of train varied from 213 to 241 tons.

The personal equations of engineer and fireman necessarily enter seriously into steam operations, and this, compounded, of course, with the peculiarities of each engine and the conditions of service, is shown in railroad reports. In this connection, I recently inspected a number of engine sheets. On one, which gave the duty of 25 engines, the average total cost per engine mile was 10·35 cents, of which 2·66 was for fuel. The total cost varied from 6·8 to 19·24 cents, and the fuel (wood) from 1·96 to 4·77 cents. On another sheet, giving the performance of 22 engines, the total cost per engine mile was 14·70 cents, of which the fuel cost 4·61. The total cost varied from 8·82 to 27·98 cents, and the fuel cost from 2·04 to 7·43. In still another, that of the performance of 18 engines, the total cost per engine mile was 14·73 cents, of which the fuel (coal) cost 6·62 cents. The total cost varied from 10·4 to 22·52 cents, and the fuel cost from 3·82 to 13·84.

In discussing the electric system there is often a confusion of statements with reference to economy. Despite the undoubted fact that the electric motor can probably be run at variable high speeds with less variation of economy than can the steam locomotive, we must not forget that in the latter we are considering the economy of the unit on a whole, not merely of the steam-cylinders, but also of the boiler and the furnace. In electric propulsion a similar comparison of economies must take into account the variable duty of the central station and the losses on the line as well as in the motor, and where single units are used, the variation in economy of the whole system would be much greater than in the steam locomotive. There will be only a reasonable fixed efficiency of the central station and the line when the number of units is large enough to make the load on the central stations nearly constant.

Let us now consider another class of duty. Some time ago I made a very careful analysis of the work done on the elevated roads in New York City, with a view of determining the coal consumption and the duty performed by the locomotives. At the time this investigation was made, now nearly seven years ago, there were in use on the Third-avenue division, 63 trains at one time, running at very close intervals. The weight of the train was from 80 to 90 tons; the speed was often as high as 20 to 25 miles an hour; stops were made every third of a mile; in short, the duty demanded of the engines was exceedingly severe. The maximum indicated horse-power of the locomotives was found to average about 163 h.p., although on occasions these locomotives have been worked up to 185 h.p. Work was divided approximately as follows: Acceleration in starting, 59 per cent.; lifting, 24·3 per cent.; and traction, 16·7 per cent. The average horse-power exerted was 70·3 h.p., considerably less than one-half of the maximum. The work on the line was so distributed that there was an almost constant total duty duty of about 4,500 h.p. The locomotives were on duty 20 hours, but used steam only six hours, and, including all losses when standing still and the amount of steam used in braking, there was a horse-power developed for about 6·2lb. of coal per hour. I believe that these

figures are entirely reliable, and they show a remarkable performance, when we consider the class of duty. An analysis of the coal expenditure showed that, with an efficiency of 60 per cent., and without any of the energy of the train being returned to the line, the relative coal expenditure between steam and electricity would be about in a ratio of 2 to 1; but if the energy of the train was returned to the line, to the extent which I believe it is possible, then the relative expenditure of fuel would be in the proportion of 7 to 2. Since the coal charge on the four divisions was at the time about 550,000dols., it can easily be seen that, independent of any question of saving, in the care of the structure and any reduction of depreciation of the motor equipment, the fuel saving would be sufficient to pay a good interest on the cost of an electric equipment; and a large interest on the cost of electrical equipment minus this value of the present engines. I have no reason to doubt the soundness of the conclusions I then made. You will have here in Chicago, however, a somewhat more advanced condition of affairs. A compound type of locomotives has been adopted for the elevated road service, and I believe it will show an increased economy over that of the operation of the New York roads. Consequently, in discussing the question of economy, it is necessary to get full information concerning the duty which will be done here.

In discussing high speed possibilities and limitations, the testimony of Dr. Dudley, as given in a discussion of a paper before this institution on the 24th of February, 1891, is interesting. There are, generally speaking, three distinct elements constituting the resistance to train movement on a level, and they have a most important bearing, when we consider the operation of long or short trains, and at high speeds. One of these elements is the friction of the train in its bearings; with good rolling-stock, this is about 3lb. per ton. For all reasonable speeds it is probably fairly constant, provided the lubrication is good. Another element is that of air resistance, which varies with the shape of the forward end of the train, the condition of the air, the direction of the wind, and the velocity of the movement. The third I may call the train lifting or rail bending effort, which depends upon the weight and stiffness of the rails and solidity of the road-bed. Dr. Dudley stated that on the New York Central system he found that trains of about 250 tons when running at a speed of a mile a minute have a resistance of from 10lb. to 12lb. per ton; but that on short trains of but two or three cars, the resistance sometimes ran as high as 35lb. or 40lb. per ton. This is probably due not to any change in the friction of the bearings, but to the fact that the air resistance enters as a much higher component of the total. It at once emphasises the fact that the operation of short trains must, at high speeds, no matter how good the track, or how favourable the circumstances, be with a train resistance higher than that required by long and well vestibuled trains. Such a shape can be given to the front of an electric locomotive as will make the air resistance not over one-half that presented by a plane surface or equal cross-section, and perpendicular to the line of motion, but even this fact does not alter the other, that the resistance per ton must be higher for small trains than for large ones.

Dr. Dudley further stated, in speaking of the influence of stiff rails, that the difference in power required on the Chicago limited when running on a 80lb. and 65lb. rail was from 75 h.p. to 100 h.p. per mile—that is, somewhere between 10 to 12 per cent. of the power actually developed—and he estimates that with a 105lb. rail, which is nearly twice as stiff as the 80lb. rail, there would probably be saved another 100 h.p. per mile, making a total saving of a quarter by less than doubling the weight of the rail. In this opinion it is perfectly safe to run a steam engine 120 miles an hour on this heavy rail. Such rail improvements increase speed possibilities with present engines, but we have not related the limit of steam duty.

Almost all the locomotive work of the United States has been done up to the present with simple engines. Their weight and capacity has been increased, their steam pressure raised until the standard is now about 140lb. Within recent years, however, the compound locomotive has come into use, and there is a comparatively large number of them in daily service. The steam pressure has gone up to 180lb. as a standard, working sometimes as high as 200lb., but these are by no means the limits of steam pressure. On the Paris, Lyons, and Mediterranean Railway, the standard for steam pressure for compound locomotives is 250lb. The compound locomotive has still its battle to fight, but I think it would be a rash man who will say that the days of still higher steam pressure are not to come, and that the triple-expansion locomotive will never exist.

Speed, capacity, and coal economy are, however, not the only questions to be considered in railroad operation, and in discussing the general subject it will be found that the signalling and braking questions at high speeds are serious ones. Undoubtedly, an electric train with distributed motors, making the weight of the train available for traction, could, by using the motors as dynamos to return the energy of the train to the line from the highest to mean speeds, and then on a local circuit, be more quickly and effectually slowed down and stopped than where shoe brakes are used, and both methods, of course, would be available But if using a motor ahead of a train, then there will be comparatively little difference in the stopping power. When riding at 60 or 70 miles an hour, it is a very quick stop to bring a train at rest in less than 2,000ft. This is often as far as any signal can be made out, especially when the weather is at all thick. Hence we may expect to find on electric railroads, if high speeds are to be attained, and quite possibly also on steam railroads, an extension of automatic signalling so that trains indicate on more than two sets of signals. At present the practice is to divide the line into sections, and when a train passes a certain point it sets a danger and cautionary signal, dropping the danger signal on the section just preceding, and the cautionary signal on the one beyond.

Turning now to the greater powers, we must not confuse the terms "large powered" and "trunk line" work. There are two statements which I think will need no corroboration. If we had a continuous train movement completely occupying a track system, there can be no question but that its operation from a central source by electricity would be more economical than if operated by steam locomotives. So, too, if a large number of units in reasonable proximity are moved, and the stopping and starting so regulated that the total demand upon the central stations is fairly continuous and equal, then there is no question as to the economy of electric propulsion as compared with steam. On the other hand, the operation of a single or very few units over a long distance would be so uneconomical and afford so small a return on the investment required as to make it prohibitory. Between these two lines the condition of operation where steam and electricity meet on planes of equality; as the number of trains decreases, steam operation is the more economical; as the number increases, electricity must be preferred.

In discussing the use of electricity instead of steam, a well-known steam engineer recently stated that in his judgment it might be conceded that E.M.F. for the propulsion of cars will not be economical, except for suburban traffic, and upon certain sections of important trunk lines like New York Central between New York and Albany, the Pennsylvania system between New York and Philadelphia, and other lines of like character where it is necessary to dispatch a large number of comparatively light trains every day, and at short intervals. The principal field for a power of this kind would be in suburban service long enough to make the ordinary street electric car unpopular because of the time required, and in such cases as these mentioned above, also for moving freight trains in city; that is, for the performance of transfer service. That is precisely in line with the arguments which I have advanced from time to time, and which I illustrated in a paper before the National Electric Light Association and its convention in Kansas City, where I outlined the possible service between New York and Philadelphia, which I believe to be practicable, and to which I will again refer I must repeat that it narrows itself then to the one question as to the number of trains operated between two terminal points. Make that number of trains sufficiently large, and the electric motor is the best means of propulsion whether for high or low speed, whether for large or

for small cars. Decrease this number and we must rely on steam propulsion, or to put it in another way, the answer to the query, will electricity take the place of steam for railroad purposes is, only in part, and then only when the number of trains operated between the terminal points is so large that the fuel economy would pay a reasonable interest and depreciation of the necessary cost of the central station and the system of conductors Of course, I do not in this general reply consider those special cases where advantages are to be gained for which there is a return for capital in another direction. Such a case is that of the Baltimore tunnel, where the investment and cost of operation will be greater than that for steam propulsion; in fact, there will practically be no economy in power, because the steam locomotives are not done away with, but simply unused for a period of a little over a mile. There is in this specific case, however, the incidental advantage of doing away with the necessity of a ventilating plan, and yet getting rid of the annoyances incidental to tunnel services.

Trunk line transportations being a great problem, we should not attempt the simultaneous solution of all the questions involved, but instead, determine what those questions are, consider their sequence, and the probability of success, and solve them in their order. Every system has its limitation. The electric is not exempt from this law, and hence it will set forth what are well-known limitating laws concerning the transmission of energy. They have been stated time and again, but somehow or another, people often lose sight of them in discussing the question of investments in large electric railways, so that I think it will be well perhaps to restate and emphasise them. The weight of copper necessary to transmit a given amount of power with a fixed loss will vary inversely as the square of the E.M.F. used. The distance to which it can be transmitted with a given weight of conductor will vary directly as the pressure. The distance to which it can be transmitted over a conductor with a given cross section will vary directly as the pressure. The weight of copper necessary where the supply station is in the centre of a system is only one-quarter that required if the station is at one end. The weight of copper will vary inversely as the square of the number of supplying stations properly placed. The E.M.F. required will vary inversely as the number of stations. Lack of knowledge of these simple and unalterable laws has led to much misconception of electrical possibilities, and these have not been confined to the electrical engineer.

In many of the suggestions which have been made, even by practical steam engineers, there has been an unnecessary confusion of impracticable and practicable, and the specific object which should have been borne in mind has been lost sight of Committees have drawn impossible specifications for trunk line service, and demanded of electric motors a capacity and performance superior to that of the best compound steam locomotives. I unhesitatingly pronounce any attempt to build some such machines for the present certainly unnecessary and impracticable. The service thus suggested, if at all needed, will for many years be better performed by the steam locomotive than the electric.

Leaving out of present consideration trunk line work, there are three problems requiring solution in the application of electricity to propulsion on a large scale under conditions existing, for example, in Chicago, or in any other place where there is a movement of a large number of trains on more or less complicated tracks as will be found at almost all terminal railway stations They are.

1. The development of an electric locomotive of ample power, which shall be as readily controlled as the steam locomotive, shall be reliable in operation, and shall show a high economy. Of course, such a machine must have all the adjuncts which are necessary for train movement.

2 A system of conductors and methods of supporting the same which can be relied upon for ample supply of current and absolute certainty of continuous contact at all speeds on curves, switches, cross overs, and the multitudinous combinations which exist on yard tracks.

3. A system of automatic block signalling, which, while effective for steam traffic, will not be thrown out of operation by the use of tracks as conductors of electricity for a general supply This is a more serious question than is at first considered, for this use will materially interfere with, if not absolutely destroy, the utility of what is known as the rail circuit system. This third problem is one which must necessarily follow the development of the other two, as the automatic signalling systems now existing have followed the development of steam practice.

While I am not by any means thoroughly familiar with the various methods of automatic signalling, I believe I am justified in saying that there is none at present existing which will meet all the requirements of railway practice, and which can be operated on track used by both steam and electric locomotive, where the rail is used as a part of the supply circuit. Some of the best-known systems of signalling would be rendered entirely inoperative. As difficult as it may seem to devise such a system, I believe that it certainly can be developed, but only properly so on a section of track which is more or less experimental, on which, at the time of operation, automatic signalling is unnecessary, but which is actually operated by both classes of service. Such an experimental section would be a combination of single and double tracks, with all the varieties of curves, crossings, switches, and ladders, such as would be found in any large yard. It will probably be found necessary to erect a variety of kinds of conductors. From the most careful consideration which I have been able to give to the subject, I believe there is one way, and only one way, in which the current can properly be supplied in any complicated system, and that is from the overhead conductor, practically rigid in character, following very nearly the centre line of all tracks and switches, with no movable overhead parts, and with return through the rail. The locomotive would then practically be moving between two electric planes, the lower being the guiding one.

I know there has been a great deal of talk about other possible systems of supply. We have heard much of the charged rail using low-potential currents, supplied at frequent intervals by motor-generators driven from a central station. Since we have discovered no conductors devoid of resistance, and the art of welding is not particularly applicable for railway service, where moving contacts are a necessity, little credence need be given to any scheme of this character. We heard again of the central rails, supported on posts, in wells between the tracks. A centre rail may be acceptable on a system like that of the elevated roads, but in ordinary railroad work any ditch intended to drain a track, so as to keep insulators dry and keep snow away from them, would probably so open the track that any moisture and frost would cause upheavals of serious character, and the cost of maintaining the track would be prohibitory. The use of snow machinery for keeping the track clear would be impossible, and anything underneath the car is in the most exposed place for sustaining damage by defective rolling-stock, and continually liable to all sorts of mechanical injuries and accidents, with all the evil results of interruption of current, short-circuiting, and stoppage of traffic.

Another system which has been proposed is that of a conductor supported on posts alongside of the track, and elevated but 3ft. or 4ft. above it. While not open to so serious objections in the matter of insulation as a centre rail system, its use where there are crossings or switches is manifestly not to be thought of. Even on a straight clear track in a hard climate there would be most serious trouble in the matter of clearing the tracks from snow, and with the grade crossings in this country gaps in the conductors would be too great for the contacts on a single locomotive to stand. Some time ago I was requested on behalf of a well-known financial man, whose enthusiasm as to the possibilities of electric traction is well known, but who is withal a most practical railroad man, to inspect various railroad terminal tracks in this city with a view of, first, the substitution of the switching work now done by a part or all of the 1,800 or more switch engines by electric motors, and eventually the operation of suburban service. In Chicago, in the space of about two square miles or more, exactly 1½ miles in length by threequarters of a mile in breadth, it is no exaggeration to say that there is or will be not less than 75 miles of track, and switches and cross

ings with their various combinations almost innumerable. I went over and over some of these tracks with the one thought in my mind, how can the current be delivered to the locomotives, and how can the automatic signalling be done? And I was forced to the one conclusion to which it seems every man who makes the investigation must come, and that is that the overhead system of supply is the only one, but that it must be as substantial and thorough in character as that of any other part of the system; and, further, that in view of the cost, such a system is only permissible where the number of units operated is large and continuous. These conclusions are not new, but they have been emphasised by the particular problem which is here represented.

Intimately connected with the question of conductors, and one of the most serious ones which has to be met by the electrician, is that of potential. The personal danger limit of continuous or ordinary period alternate currents, is pretty well determined, and it seems generally admitted by constructors that the danger limit for a continuous-current machine, with its commutator, is about the same as the personal danger limit. Hence we meet with two dilemmas. If using continuous-current motors, we are limited to a difference of potential per machine of 1,000 to 1,200 volts, and we can, so far as safety of the machine is concerned, only probably go above this limit by putting the motors in series, precisely as has been proposed for long-distance stationary transmissions. If this is not done, then we have the introduction between the transmitting dynamo and the receiving motor of a motor-generator system—another pet theory which is often suggested, but which I unhesitatingly pronounce as so uneconomical as to be impracticable. If using an alternate-current system, the converters must be used, either distributed along the line and supplying the working circuit or placed upon the locomotive to safeguard the motors. While the use of a converter under these conditions is not as objectionable as the use of the motor-generator, it cannot commend itself as a very practicable scheme, and certainly in view of the fact that no single phase single alternate motor promises, up to the present, serious success. For the present, and I think for a long time to come, we must confine ourselves to the consideration of railroad problems where continuous currents are used, and where the traffic between two points is sufficiently large to justify the investment in central stations and conductors which would be required for the operation of such a system.

There are two methods of propelling trains electrically, one by following steam practice—that is, by building a large motor, and hooking it to the head of a train—the weight of the motor being such as is required for the necessary power and traction when grades or slippery tracks are encountered. From all that has been developed up to the present, to get the control that is necessary, and to build the machines safely, the electric locomotive will weigh nearly as much per horse power as the steam locomotive. This weight can be better distributed, but I do not think if steam practice is followed on trunk line service that there could be any very material reduction of weight of train. The other plan is to have each car propelled by one or more motors. This would be the ideal system so far as propulsion goes, provided the electric motor was unlike all other mechanical apparatus and that it never failed, and if a number of machines could be as well taken care of, cost no more, and show as little depreciation as fewer machines of larger capacity operated as a unit.

Should we ever arrive, as we all hope, to the possession of a single-circuit alternate-current motor, then, in view of the simplicity of its control, we may fairly hope for the distributed-motor system. But here also, the capacity and likewise the weight of the motor being determined by the total duty done, the weight of train limit would not be decreased, but rather increased. If, on the other hand, single units are used, the query naturally arises, What form would the electric locomotive of the future take? I do not think this is by any means settled; undoubtedly, gearless machines will be used, but whether they will be mounted directly upon the axle, or whether they will movably enclose the axle and be flexibly connected to it, while their weight is carried on springs on the truck, or whether the motor will be carried on the truck frame and connected to the drivers by the ordinary coupling rods, are questions which will be determined eventually by the depreciation per car mile upon the motors, trucks, and road bed, as well as by the speed to be attained. Whatever method of mounting the motor is adopted, for reasonable weights and powers a two-axle truck will be used, but where the large powers and weights are necessary, two such trucks will be coupled together, so as to keep the weight upon each wheel within limits, and this will carry a cab containing the regulating and collecting devices, and so shaped as to offer the least resistance to air pressure and high speeds. I have never advocated the use of a connecting rod in transmitting the motion from an armature to a driving axle, but I think it fair to say, in this respect, that the so-called hammering effect on the rails, said to take place in the ordinary locomotive driver, where the weights are counterbalanced, exists more in imagination than in fact, and that the chief trouble in the use of the connecting-rod is the change of direction of its movement.

Among the roads which are ripe for the electrical engineer, and on which in the near future I hope he will demonstrate he has a most legitimate claim, are the New York elevated and Chicago elevated, the handling of the trains on the New York Central and Harlem roads below the Harlem River, the long talked of rapid transit road of New York, the Metropolitan underground road of London, the proposed tunnel roads of London, Paris, and Berlin, and, coming more immediately home, suburban service such as that of the Illinois Central Railroad, a most ideal track for the electrical engineer; and last, and, as it will prove, one of the most important, the operation of terminal and warehouse systems for the interchange of freight on the lines entering a city situated as is Chicago. Taking this last, we have here a definite problem, now performed in a more or less satisfactory way by steam service. It is a problem large enough of itself. It has little connection with electric trunk line service, and the present impracticability of the latter has little bearing upon the thorough practicability of the former. Eighteen hundred or more switch engines, many of them on duty 24 hours a day, a large portion of the time standing idle, puff their foulness into your overburdened atmosphere, because from 80 to 90 per cent. of all the freight that comes into the depôts of this city ought never come inside its limits, and would not were there a practical way provided to distribute it from one railroad to another outside the city limits. It has been suggested, and it seems to me a most feasible plan, that there shall be established a vast system for interchanging freight on the various railroads by a great six-track crossing belt road which shall form a common zone of transfer either by itself or in combination with freight warehouses or storage yards. Undoubtedly there are many difficulties in the way, but from an electrical standpoint there is absolutely no question but that such a system of belt line is practicable. With such unsolved problems, such abundant fields, I deem it unnecessary to attempt to build electric locomotives to pull trains of great weight 100 miles an hour, or to develop a system of conductors for trunk line service which is not possible for yard duty, or to consider a central station or track equipment for a duty not required. This problem is in a measure an experimental one, which being carried to a certain measure of success will clearly point the way for future development and outline its limits.

I may be pardoned perhaps if I take radical views in some matters of railroad practice. I have fortunately or otherwise been thrown into direct touch with all the larger work which is to be done in this country during the coming year, and it gives me pleasure to announce what many of you know from the current news of the day, that there will probably be in operation in the United States within 12 months not less than five locomotives varying from 700 h p. to 1,200 h.p. and from 45 to 80 tons in weight. The character of the work done will vary. In that work in which I am most concerned from a personal standpoint, a 700-h.p. electric locomotive will be built for experimental work, and to attempt to solve as far as may be the various problems which are involved in railroad practice

in Chicago. If my judgment is followed, there will be an experimental section of track in the form of a loop about 13 miles long with 18 miles of rail, and with every variety of single and double track construction and simple and compound crossings and switches. On this I hope to see erected such varieties of overhead construction as may be found best to meet the various kinds of service, and where the railroad problems on track jointly operated by steam and electricity can be developed in the most satisfactory manner. On this track there will be not only this locomotive but also one of equal rated capacity supplied by one of the larger manufacturing companies. The duty demanded of these machines will be severe. They will be required to haul a train of not less than 450 tons at 30 miles an hour up a grade of 26ft. to a mile. They will probably be required to develop their full rate of capacity at all speeds between 30 and 60 miles per hour, and if there is sufficient track room they will be driven at speeds of at least 75 and perhaps 100 miles per hour for short distances. The potentials used will be nearly double that at present obtaining in street railway practice

A still larger problem so far as power goes, although not in the variety of conditions which will have to be met, will be that recently taken for the operation of the belt line tunnel now being constructed in Baltimore to avoid the necessity of boat transfer to Locus Point. The duty of the motor here will be to propel the trains with engines coupled on but not in operation through a tunnel about 6,000ft. long. The conditions require the motors, which will weigh about 60 tons, and have a capacity of about 1,200 h.p., to propel a 1,200-ton freight train up a grade of 42ft. to the mile at a speed of 15 miles. Passenger trains of 450 tons weight must be regularly started from rest twice in the tunnel on this grade, and in an emergency the motors must start the freight train. The draw-bar pull under regular duty, and when not starting, may be as high as 32,000lb. Perhaps the traffic from New York to Philadelphia affords as good an example as any of what may be done on regular passenger service, provided the track is clear enough. For this I some three years ago outlined a service and again in the Forum of September, 1891, an electric express service with a method of supply through a rod carried above the car and a return circuit through the rails and earth. The current was to be supplied from one or more central stations equipped with high-class triple-expansion engines driving multipolar dynamos directly coupled. What the electric engineer, and the railroad man as well, needs to know is whether the E.M.F. required on the line and the number of stations necessary would be prohibitory. No attempt was made at excessive speed, but I confined myself to the average speed of a mile a minute for a distance of 90 miles, and considered a through service only. I assume a total weight of copper of only about two-thirds that which existed on the long-distance telephone line between New York and Boston. The trains were to be two car units leaving every 10 minutes. I found, with these conditions, the stations and potentials would be about as shown in the following table:

Stations.	Miles apart.	Potentials. Two-wire.	Three-wire.
1	—	3,600	1,800
2	45	1,800	900
3	30	1,200	600
4	22½	900	450

If the three-wire system is used—that is, the rails as a compensating conductor, between two trolley rods—then with only two stations 45 miles apart, it is seen that the potential is less than 1,000 volts, and this we undoubtedly can handle. I am not prepared to say that we may not use even a higher pressure, because I believe whatever is demanded in the interests of economy, all things being considered, will be used, but if we can reduce the potential to perfectly safe and reasonable limits by multiplying the number of stations, then these stations should be increased so long as the increase does not seriously affect the general expense of working. On a service of this character, where I have made the conditions distributed work, and the dispatching of units at brief intervals, which conditions, I repeat, are absolutely necessary, if we are to consider long-distance transportation by electricity, such increase of stations as is advisable will not increase the cost of central station operation.

Such is the work before you—a work well meriting your best efforts, yet is well to temper your enthusiasm with prudence. Limit your attempts to the solution of those problems which will prove of practical benefit. Do not chase rainbows. They are beautiful and poetic, but they have small place in the world's economies. Remember that neither sentiment nor ignorance are winning cards, but lessened cost of operation for equivalent duty and increased returns on invested capital. All this is said in no spirit of discouragement, for I yield to no man in my confidence in the future of electric traction. No new field is so rich, none more pregnant with great possibilities, but the growth of the work will be more expeditious and healthy if we separate the visionary from the real, the impracticable from the practicable.

WATERFORD.

At the meeting of the Corporation last week the town clerk read the following report of the Lighting Committee:

Having had an interview with the committee of the Harbour Board, we are now in a position to report finally on the question of the public lighting of the city. We give below the relative cost of each system of lighting, and beg to submit to the Council for its approval the annexed resolutions, which we have agreed upon as being fair and reasonable to all parties. It will be seen by the figures submitted that the cost of lighting the city by electricity and gas will be £120 per annum in excess of lighting by gas alone, and £210 per annum in excess of electricity and oil, and that the cost of lighting the whole city by gas will be £90 per annum in excess of electricity and oil. We may mention that the Harbour Board contribution in future will be £120 per annum, conditionally on the continuance of the same number of arc lamps as at present, that Board undertaking the lighting of the hulks themselves by gas.

SUMMARY OF PUBLIC LIGHTING.

	£	s.	d.
Gas.			
394 lamps, at £2. 15s.	£1,083	10	1
Extra on large lamps	112	10	0
Clock tower	10	0	0
Sallypark Corporation contribution	7	10	0
	£1,213	10	0
Electricity and Gas.			
34 arc lamps, at £24	816	0	0
210 gas lamps, at £3	630	0	0
Sallypark Corporation contribution	7	10	0
	1,453	10	0
Harbour Board contribution	120	0	0
	£1,333	10	0
Electricity and Oil.			
34 arc lamps at £24	816	0	0
210 oil lamps, at £2	420	0	0
Sallypark Corporation contribution	7	10	0
	1,243	10	0
Harbour Board contribution	120	0	0
	£1,123	10	0

"Resolved,—That we are prepared to offer the electric lighting company £24 a lamp for five years for the public lighting of the city, and that we are also prepared to assign to them our powers under the provisional order for a term of 10 years, on condition that it be within the power of the Corporation to purchase from them at a valuation based on an arbitration, one arbitrator to be appointed by the Corporation, one by the electric lighting company, and in case of disagreement, an umpire to be called in, with the proviso that should the Corporation be not in a position to so purchase from the company, they will be prepared to grant them a further term of 10 years of their provisional order, they (the company) providing all necessary expenditure for cabling and wiring the city. That, further, we offer the gas company £3 per lamp for five years for the public lighting of that part of the city at present lighted by oil. That, in case the electric lighting company refuse our terms, we ask the Council for permission to make immediate arrangements with the gas company to light the entire city by gas at their tender of £2. 15s. a lamp, with the addition of the large lamps as required."

After considerable discussion the report was adopted.

Atlantic Lines.—The Directors of the Atlantic First Leased Lines Rental Trust, Limited, have declared an interim dividend of 2½ per cent. for the half-year ending July 31, payable on August

THE

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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CHICAGO EXHIBITION.

The London Chamber of Commerce, as well as other local Chambers, is taking considerable interest in the Chicago Exhibition. At the meeting of the Electrical Section the other day, energetic, but not manufacturing, members urged, to the electrical industry, the general participation in this exhibition. We have received from the London Chamber of Commerce a list of thirteen exhibitors who have applied for a total of 4,739 square feet of floor space. No sketch of the imagination could represent these thirteen exhibitors as representative of the English industry. Two or three stand in the front rank, the remainder are more or less in the category of exploiters, and to them Chicago is as much a field of operation as is London. The time has long since gone when even international exhibitions were looked upon as anything other than business concerns. There might have been pride of initiation and sentimental feelings in 1851, but now exhibitors do not exhibit from patriotism, but with a view to obtain custom. It matters nothing how the custom comes, direct or indirect, and ofttimes the indirect effects are far more valuable than the direct. "We have not cleared our expenses" is the cry too often heard. That is not the question. Has the general volume of business increased? If it has, it is but just to attribute the whole or a part of the increase to the taking part in exhibitions. Thus the direct orders taken at the late Crystal Palace Exhibition may not have paid the exhibitors—but the balance-sheet of that exhibition cannot be closed for months, if for years. The seed sown will bear fruit, and the installation of some town in '93 may really be due to the exhibit of '92. Partners and managers are not slow to realise all this, and no doubt have thoroughly examined into the possibilities of the Chicago Exhibition. Their hesitation to apply for space seems to indicate a conclusion adverse either to direct or indirect business. So far as the Chicago Exhibition is concerned, the business part of the matter seems exceedingly simple. Our engine-makers and our dynamo-makers, except in the case of those owning patents in the States, can hardly hope to open up business in the States. We may be able to sell a dynamo here and there, but nothing like an extensive business in this direction can be forthcoming. In the thousand and one accessories to electrical work in lighting, traction, telegraphy, and telephony, agencies may be opened and sales effected. So far, then, as the States are concerned, we may put on one side any wide prospect of increasing our engineering business. A more important question, however, is, how will this exhibition affect electrical enterprise in our colonies and in other countries outside the States from China to Patagonia. Will likely buyers wend their way to the exhibition from all these quarters? Take Australia, and confine the consideration to electrical apparatus. Almost all our large makers have agencies in Australia, many have installations at work, and they must decide whether many purchasers are likely to be lost by visiting Chicago and seeing competitors' manufactures. There can be no doubt but that thousands of visitors from our own

colonies and from South America and Asiatic districts will visit this exhibition; only a portion of those visitors, however, will be interested in electrical matters. It is this question of colonial business that has induced some of the thirteen to apply for space, and it may be that others who have hitherto held back have not sufficiently considered this point in the problem. The discussion at the London Chamber of Commerce brings it before them, and it is not too late to change their views. The argument that these exhibitions mean our giving to rivals the secrets of our practice and making them a present of our designs, is pure and unadulterated rubbish. If a rival wants to know all about a machine, he will buy one and study it in detail in his own works. He does not expect to gain much information at exhibitions. Of course the man who is so cocksure that everything he does is infinitely superior to anything anybody else does, can never be made to understand that he is really very much like other men, only perhaps more so—having as much to learn as to impart. We are thoroughly of the opinion that if it is worth while exhibiting at Chicago at all, it is worth while doing it well. A few paltry exhibits are neither indicative nor representative of the industry, and give visitors no idea of what they may expect to find in this country. Our intention is not to decide for or against, but to point out a few of the facts which must be carefully considered before coming to a final decision. One thing is certain, the expense is great. If, on the other hand, the return is commensurate, go ahead.

FOREIGN COMPETITION.

A very comprehensive subject was just touched upon at the Electrical Trades Section of the London Chamber of Commerce last Friday, in the shape of the idea expressed by the title of this article—that bugbear of British manufacturers, from makers of tintacks to shipbuilders—foreign competition. The problem was brought forward by Mr. Edmunds, who, however, was prevented from being present to expound his views, so that we may expect a further development in the future when the section meets again in October. Seeing the question was raised although but tentatively, it may, perhaps, be well to dwell for a moment on what must tend to become a more and more pressing problem. When we are told that English electrical manufacturers can produce the best goods in the world we may be inclined to agree, but there are other factors to come in besides quality; and these are cheapness and push. We must leave the discussion of cheapness for the present. As processes tend to improve the cost of production alters, and the effect of the higher price of labour is as often to lower the cost of actual production as not—witness the products of the United States. The item denominated "push" is perhaps the principal one in leading and keeping the markets of the world; and English manufacturers are at present—now home wants are becoming rapidly supplied—turning to foreign and colonial markets. What we find here is that American and German, not to mention Belgian, manufacturers are running, not only close, but often far ahead in the supply of electrical requirements. The industry has been in a curiously international state up to the present, and American, German, and English manufacturers have jostled side by side for abiding place on British soil. The industry has now settled down to steady work, and the problem is the competition, not of systems of this or that country, but of the companies and firms of this or that country—quite a different affair, and that which is meant when speaking of foreign competition.

We see, in looking around, the steady progress of American engineers in fields hitherto covered by British manufacturers. Australia is well canvassed by the great companies of the States, who can do this the more easily as the recent amalgamations have concentrated their forces. In Europe, Hamburg has recently purchased a hundred thousand dollars' worth of American cable; Brussels, itself a busy engineering centre, has succumbed to the wiles and the skill of Thomson-Houston as regards its tramways, though here Britain may score a success in the electric light station. German firms are doing an immense trade, home and foreign, and with large central works at Berlin have branches in various departments in all parts of Germany, in Switzerland, Brussels, and London. Their technical colleges are the best equipped that money can procure. The students are trained not only in technics, drawing, engineering, practice and theory, but in commercial proceedings, and in languages. Hardly any well-educated German student but knows French and English well, besides his own tongue, as well as being trained in the art of playing into each other's hands. They recognise the value of foreign markets, and know how to set to work to acquire them often before the insular Briton has awakened from the short-sighted policy of waiting for orders from home. Circulars in various languages, properly-equipped travellers, and a good use of the foreign State consuls—these are all part of the organisation that must be used to secure the foreign and colonial market. Britain is a mere sixpenny piece on the map of Europe, without her Imperial possessions, and the great and immediate advantage of keeping in personal touch with Imperial Britain has been abundantly shown by the result to Messrs. Crompton for their enterprise in sending one of their directors a business tour around the globe. We in England are often too frightened at a voyage. To go to Paris, or even to Dublin or Edinburgh, is quite an undertaking, while how many engineering firms would send off an engineer on the spur of the moment to Vienna, Malta, Gibraltar, Ceylon, or Calcutta when a prospective engineering order is on the cards? Yet American firms think nothing of two or three days' or a week's journey about the States, or a month in Europe. The fact is, that most people in England have not yet realised the extent of the world, the necessity for learning the spoken foreign languages, or the fact that British consuls exist all over the world for the main purpose of affording a means of information to aid British trade. It is time the Chamber

of Commerce did take the question up as far as they can do so. We hear as we write that an order for four hundred twelve-ampere arc lamps and dynamos to match has just been given from Manchester itself to a Belgian electrical engineering firm. Here is a fitting item to emphasise the contention of Mr. Edmunds, that foreign competition is a matter of vital interest to the British trades and is worth a little serious attention.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WESTINGHOUSE TRANSFORMERS.

SIR,—Referring to the report of Dr. Hopkinson on our transformers (copies of which have been sent to you), we have just received an intimation from Dr. Hopkinson that an error has occurred in the last paragraph but one—namely, the efficiency of the transformer at quarter load should read "over 92 per cent.," instead of "84·7 per cent."

We should feel much obliged if you would kindly refer to this in your next issue.—Yours, etc.,

ARTHUR E. SCANKS, Secretary.

Westinghouse Electric Company, Limited,
4, Victoria mansions, 32, Victoria-street, E.C.

DEATH OF MR. CYRUS FIELD.

We regret that since our last issue Cyrus Field has passed into the great unknown. Born in 1819, he had reached the ordinary span of life. He died on Tuesday last. As we said in our leader last week, he was the real initiator of Atlantic cable enterprise—an enterprise the success of which has revolutionised the business transactions of the world. Cyrus Field had made a competency and retired from business when, at the instigation of F. N. Gisbourne, in 1854, he became interested in cable work. Few men have left deeper "footprints in the sands of time" than he of whom we write.

CYRUS FIELD.

THE SUCCESSFUL PIONEER OF SUBMARINE TELEGRAPHY.

To the Editor of THE ELECTRICAL ENGINEER.

SIR,—As one of the many thousands of admirers of the late Mr. Cyrus Field, I read your expressive article which appeared in last week's issue relative to this remarkable man with interest, and I feel sure that every electrician and telegraphic operator will receive with profound regret the sad intelligence of his decease, which this week has been wired over the same ocean in which his pioneer work was commenced. This eminent personage may truly be called the founder and father of successful submarine telegraphy. Although it is said that the idea of conveying flashes of lightning may have been inspired by the writer of the Book of Psalms (for in chap. xix., 4, it is stated "Their line is gone out through all the earth, and their words to the end of the world," which words clearly show that even at that remote period there existed crude ideas respecting the future utilisation of the subtle fluid and ethereal energy called "electricity," which combination of matter and force was first christened by this name in the year 1600 by the late Dr. Gilbert, of Colchester), yet from published reports it is evident that the germ of the modern idea of its utilisation and application for purposes of submarine telegraphy is due to and emanated from Mr. F. N. Gisbourne, of Montreal, and Mr. W. F. Armstrong, of New York, whose suggestions were practically brought to a successful issue under the guidance and perseverance of Mr. Cyrus West Field, and the assistance of his co-workers in the enterprise, which included the late Sir Charles Bright, Mr. Whitehouse, Mr. J. W. Brett, and the present Lord Kelvin (then known as Prof. Thomson).

It has often been said that the true character of a man may be judged by "phrenology," also by his conversation and speech. Now, if the latter be true, then I venture to say that some of Mr. Field's sterling qualities may be judged by a perusal of the pretty little speech he delivered at the inauguration of the landing of the first Atlantic cable in Valentia Bay, which, according to history, took place on Wednesday, August 5th, 1857. And, in reply to a request of the Earl of Carlisle, the then Lord-Lieutenant of Ireland, and an influential assemblage, Mr. Field said, "I have no words to express the feelings which fill my heart to-night. It beats with love and affection for every man, woman, and child who hears me (cheers). I may say, however, that if ever at the other side of the waters now before us, anyone of you shall present yourselves at my door and say that you took hand or part, even by an approving smile, in our work here to-day, you shall have a true American welcome. I cannot bind myself to more, and shall merely say 'What God hath joined together let no man put asunder,'" words which I think clearly show the character of this remarkable man.

As many of your readers may not be acquainted with the personal history of the eminent personage who has done so much for the world at large, I would briefly state that Mr. Field was born in the town of Stockbridge, in the State of Massachusetts, in November, 1819. His father was the Rev. D. D. Field, a graduate of Yale College, and the late Mr. Field was one of seven sons, all of whom have held distinguished positions in the United States. One brother, the Hon. D. D. Field, of New York, is well known on both sides of the Atlantic as one of the revisers of the code of the State of New York. Another, M. D. Field, was a leading citizen of Massachusetts, and for some time a senator. His brother Jonathan Edward Field was at one time a judge in the Supreme Court of California—the judge who has recently tried several important infringement cases in the United States in connection with electrical science. In early life, it appears that Mr. Cyrus West Field—better known as simply Cyrus Field—occupied a position as clerk in the well-known drapery establishment of A. T. Stewart, of New York. Prior to his taking up the science of telegraphy, which commenced in the year 1854, he had previously founded a large paper manufactory in Massachusetts and a commission merchant's warehouse in New York, and by his association with Prof. Morse became initiated into the merits of telegraphy, and thus took a great deal of interest in the advancement of the same. His pioneer efforts were in connection with the formation of the New York, Newfoundland, and London Telegraph Company, which afterwards by his splendid organisation, patient perseverance, and indefatigable energy, was converted into the Atlantic Telegraph Company. The success of this company, although after many attempts to overcome failures, is now well known throughout the entire world as one of the greatest events of the present century, and Mr. Field's work in connection therewith has been the means of linking nations in the bonds of union and finding employment for thousands. Hence I crave a small space in your journal to record a brief account of the grand work pioneered by the above, which work has rendered such service to mankind, not only to signal important events of the day, but also to flash the transmission of thought in all known languages from one part of the globe to the other.

For the past 15 years Mr. Field was prominently connected with the New York Elevated Railway, the success of which is also greatly due to his tact and assistance; and, therefore, with two such gigantic and marvellous successes, his name cannot fail to be handed down to posterity as one of the foremost pioneers of the present century.—Yours obediently,

July 13th. ARTHUR SHIPPEY.

LONDON CHAMBER OF COMMERCE.

A meeting of the Electrical Trades Section of the London Chamber of Commerce was held on Friday last at the offices, Botolph House, Eastcheap.

The SECRETARY read the minutes, which referred more particularly to the appointment of a special electric traction committee and the deputation to the Board of Trade with

reference to overhead wires. We have already given particulars of the result of this deputation.

THE USE OF EARTH.

The Electric Traction Committee (consisting of Mr. Morse, Mr. Greathead, Mr. Gain, and Mr. Sellon) had been appointed to deal with the very important question of the use of the earth return by telephone and tramway companies. Major FLOOD PAGE explained that the section desired to do all they could to save litigation between the telephone and tramway companies, which might involve the cost of £100,000. An action was now pending between the National Telephone Company and the Roundhay Electric Tramway Company (Mr. Graff Baker)—and on one side it was said this suit would settle the question for ever, while on the other, that it would not settle it at all. The committee had gone a step in advance, and a meeting was to be held in a day or two, to attempt a settlement of some *modus vivendi*. The reason of the difficulty was the insistance of Government upon the insertion of protective clauses for the telephone companies in the Bills for electric railways. It was maintained, on the one side, by the electric tramway companies that they had as much right to the earth as the telephone companies, and that with a small outlay for twin wires they could obviate all disadvantages. The telephone companies, on the other hand, maintained that the present system was sufficient for their purpose and that Parliament acknowledged their rights by the insertion of protective clauses in all electric railway Bills. It had been pointed out, however, by Mr. Sellon that the Sandgate and Hythe Bill did not contain these clauses. Mr. Bennett, of the New Telephone Company, had suggested a halfway measure in the Maclure system, in which a second circuit for every two wires was used instead of entire duplication. Major Flood Page hoped that it was possible to agree upon some arrangement that both parties should have the use of earth, or in any case that something might be done to avoid litigation.

CHICAGO EXHIBITION.

The next item on the agenda, and the principal one before the meeting, was the representation of the electrical trades at the Chicago Exhibition.

Mr. W. H. PREECE, who had been invited to attend and explain the position, said the chances of a successful display by the British electrical industries at Chicago was at present very remote. On the other hand, in the industrial arts' section, the most magnificent display ever sent from this country to any exhibition was going to Chicago from over 1,500 exhibitors. The space here had to be extended, while out of 20,000 square feet given for electrical exhibitors only 5,000ft. had been taken up. Those who had sent in applications included the Epstein Company, accumulators, 220 square feet; the Electric Construction Company, 1,000ft., a large show; Parsons and Co., 220ft., three types of turbo-generators; Willans and Robinson required a large space; Ferranti and Co., alternate current motors, dynamos, and other apparatus; the General Electric Company; and the Post Office, who would send over the historical display shown at the Crystal Palace; of the rest there were only Robert Ewing, conduits; J. G. Lorrain, ventilation, Anders and Kottgen; Elmore's American and Canadian Company; London Electrometallurgical Company, silver-plating; the Phonopore Syndicate; the Collier Telephone Company; and the Homacoustic Company. He thought they would agree with him that, as the matter stood, the British electrical industry would not be adequately represented. His object in attending the meeting was to endeavour to obtain the assistance of the Section to secure some complete and typical exhibit of the methods of central station work and the lighting of private houses and buildings in England. He thought it might be possible to form a kind of syndicate amongst proposing exhibitors to fit up houses with complete suites of English furniture and electric fittings all of the best kind. He thought a number of firms might be asked to subscribe a sum, such as £250 each, to exhibit their wares. Government was prepared to give some help. Circulars had also been received from the Chicago authorities asking English contractors to tender for the lighting of certain places set aside for European exhibitors.

Mr. GARCKE said the section was greatly obliged to Mr. Preece for his explanation and suggestion. He thought a number of firms might respond, and suggested a circular should be issued. At the same time he thought a smaller guarantee than that mentioned would suffice. With the larger firms the question was more difficult, as they had difficulties in exporting their machinery, and no great hopes of extending their business in America.

Mr. BINSWANGER said that the main question should not be lost sight of—Chicago was an exhibition, not for the United States alone, but for foreign countries, and would be a great meeting place for persons from South America, Canada, and the Colonies. It was of the utmost importance to English manufacturers to have a good exhibit. Electrical engineering had passed its experimental stage, the resources are great, and the race for foreign markets will be extremely keen, and in this direction the Chicago Exhibition would have a very great importance. He mentioned that during the last three or four years his firm had established business connections in Canada, Mexico, Japan, and China, and in nearly every case his customers told him they intended to visit Chicago, and hoped to see their goods. The progress made by English men of science and the fire offices in safety, in costly engines and dynamos of immense capacity, have set the industry on a sound and independent basis as compared with that of other nations. He thought it well for every class to be represented in the electrical section, as where a customer bought dynamos he would prefer also to buy fittings, cables, and lamps.

Mr. PREECE, in answer to a question from Major Flood Page, said it was distinctly conceded that British manufacturers could mark their goods with English as well as American prices; and although there had been rumours that the McKinley party intended to refuse this right, Sir H. Trueman Wood, who had gone over with a strong ultimatum in case this were true, cabled back the first day that everything was arranged most satisfactorily.

Mr. ERSKINE suggested there need not be great expense in fitting up houses, as the furniture firms would doubtless be glad to exhibit.

The SECRETARY (Mr. Murray) said he had recently approached the wholesale furniture firms, and would do so again. If one trade commenced the others would join.

Mr. MARSHALL stated that the steam engine makers had practically resolved not to exhibit. The agricultural engineers had had a meeting, and decided unanimously that it would not be advisable to send to Chicago on account of the prohibitive duty and the large expense.

A committee, formed of Messrs. Garcke, Flood Page, and Binswanger, was appointed to draft a circular, Major FLOOD PAGE remarking that his own company were in the difficulty, as were several others, as they could not well compete with their parent companies in America. When the circular was answered they would call a further meeting, probably in October. Mr. PREECE thought they could not do better.

OVERHEAD WIRES.

Major FLOOD PAGE gave a report of the deputation, consisting of himself and Mr. Edmunds, which waited upon the Board of Trade with reference to the proposed Overhead Wires Bill. He went over the points, which were given in our report of that deputation, stating that out of 22 clauses they objected to all but five. All had been settled satisfactorily to the electrical trades, save the last and most important one—the clause by which owners of wires were compelled to give or secure permission for the officers of the local authority or the County Council at all reasonable times to inspect the wires and standards. He pointed out that this would be most restrictive to the telephone industry, as wayleaves would be simply refused under this condition. The companies should rather be required to "endeavour to obtain permission."

Mr. A. R. BENNETT expressed great gratitude on behalf of his company for the work Major Flood Page had done. The companies were now contented with the by-laws with this one exception. Wayleaves were difficult enough to obtain already; with this restriction they would become well nigh impossible to obtain.

General WEBBER thought there should be little difficulty in introducing into the wayleave agreements a

clause which would permit an official of the local authority, in the interest of public and private safety, to inspect the attachment by the officers of the company. With such a clause, worded carefully, he did not think that wayleaves would be refused. As to the wayleaves already obtained the question was much more difficult. In such cases the local authority are bound to show how the leave to inspect is to be obtained.

A resolution was carried, empowering the committee to do their best to obtain amelioration of the objectionable clause.

OTHER MATTERS.

Mr. EDMUNDS had placed on the agenda for discussion the following questions: Standardising of machinery; uniformity of prices; and foreign competition. In the enforced absence of Mr. Edmunds, it was thought these subjects were too wide to discuss at that meeting.

The section then agreed to adjourn till October, unless something of importance should arise in the meantime.

THE CRYSTAL PALACE EXHIBITION.

THE HIGH TENSION EXPERIMENTS.

BY SYDNEY F. WALKER.

In his previous article the writer omitted to mention one very great advance that has been made in the 10 years which have elapsed since the former electrical exhibition was held at the Crystal Palace.

In 1882 we were using tensions of 2,000 volts, but we were doing so in a timid sort of way, fearing that some accident or the other would happen. And accidents did happen, cutting off men in the prime of life, or occasionally allowing them to be rescued by a friendly knock-down blow from a fellow-workman. To-day we are using tensions of 10,000 volts, without accident to life so far; and tensions of 2,000 volts, whatever may be said as to the wisdom of employing them, are quite common. But, more than that, we have had Mr. Nikola Tesla showing us that very high tensions indeed may be used, provided that certain conditions accompany their use, and we have also, day by day, one of Messrs. Siemens's electricians handling tensions of 20,000 volts and 50,000 volts with the same ease and safety that we handle an ordinary 100 volt electric light service.

But, apart from the striking advance shown by these facts, the experiments themselves that are performed by Messrs. Siemens's representative afford us many very important lessons. They bring us a good deal nearer many of the puzzling phenomena that we are accustomed to associate with lightning discharges, while, on the other hand, they show us that the currents produced by means of these high voltages obey the same laws, whatever form they take, as currents produced by tensions of only 50 or 100 volts. We see, on the one hand, by the aid of these high tensions, phenomena that usually take months, or, perhaps, years, to mature, brought about in a few minutes, and, on the other hand, we see before our eyes, by the aid of currents produced by high voltages, the power that is able to perform many of the mighty feats for which lightning is noted.

Often have students of electrical phenomena, when studying the apparent freaks of lightning discharges, been puzzled, nay, baffled, by the stupendous nature of the work performed—work that is frequently out of all apparent reason, when compared to the power that is present. We hear, for instance, of a huge coping stone, forming part of the massive tower of some old church, hurled violently out of its place because the lightning discharge had a fancy to pass through to an iron rod on the other side. Or, again, for no apparent reason, beyond the existence possibly of a gas-pipe somewhere near. Sober, solid looking washstands with heavy marble tops have been known to execute something like a war dance. Whence comes this power? Some years since, the writer's observation, following on a remark of Mr. Preece's, led him to the conclusion that the secret source of the enormous energy exerted in the above phenomena was to be found in the instantaneous generation of steam from the water present within the pores of the stone, brickwork, etc., passed through by the current. It is well known that all brick and stone, even the closest, are porous, and therefore hold a certain quantity of water in suspension, that being the reason so many of the walls of our houses are damp. It is also well known that when water is converted into steam, it immediately occupies a space 1,700 times that which it occupied as water. Given, therefore, the facts that water is present in these brick or stone walls, that it is converted instantaneously into steam *in situ*, and we have expansive energy enough present to account for all that has previously so puzzled us.

But up to the time the high-tension experiments before referred to were made, the reasoning given above, though apparently sound, was necessarily based on theory to a large extent. Now, however, we have the whole phenomena produced at will before our eyes, and with a much lower voltage than we know to be present in most lightning discharges. Is it thought an extravagant idea to suppose that a spark, or a lightning flash, which is the same thing, could pass through porous, waterlogged bricks and stones? Here we have it passing through solid glass. Is it thought a stretch of imagination to conceive that steam is generated from the water held in the bricks or stones? Here we have steam formed from dropping water under our own eyes, and not only that, but, if the writer's recollection of the experiment serves him aright, actually decomposed into its constituent gases, and the inflammable one, hydrogen, set on fire.

Again, in the early days of electric lighting, such phenomena as the following were frequent, and in these days are still occasionally to be seen. An apparently non-conductive wood board, such as a wire casing, after having been in use as a protector of electric light wires for some little time, suddenly becomes a charred mass, and perhaps sets fire to neighbouring combustible material. How does this happen? A study of the principles of the science leads to the conclusion that the moisture held in the pores of the wood forms a path for a small current of electricity which silently, and usually imperceptibly, alters the nature of the wood altogether, gradually converting it into a conductor of sufficiently low resistance to allow a larger current to cross and then at some favourable point to throw a spark; the latter phenomena being followed by the charring of the wood, or its complete combustion, according to the conditions present.

But, though we can be reasonably certain of this from careful and long-continued observation of the objects, after the work is done, we cannot see it in actual progress. We hardly even suspect it, except by the indirect method of frequent insulation tests, and then not with any degree of certainty. In the experiments at the Palace, however, we see the process actually going on. We see a piece of wood placed in such a position, and of such a length that we should say it was practically an insulator for currents of ordinary lighting voltage. Yet, again, under our own eyes, and in the space of a few minutes, at the bidding of the operator, we see the wood gradually lose its normal appearance; we see it gradually change till it becomes a charred, blackened mass; we see sparks apparently darting through its mass, igniting small outlying splinters and finally we see an arc formed clear across the charred mass while the latter is evidently still conducting some portion of the current.

In the writer's opinion, this is very much what goes on in all cables which have a conductor in close proximity to the outer surface of the insulating envelope. Just as with the glass, and the stick, when exposed to the pressure of 20,000 volts, a state of severe strain is set up, which will in time break down the insulation at some favourable point, and possibly set fire to combustible material in the neighbourhood. The writer has had a case under his notice where with a pressure of only 65 volts, a spark passed between the inner copper conductor and its iron external armour, fusing some of the iron wires and setting fire to a cargo of cotton which it passed through, and which that type of cable had been specially designed to protect.

Do not these experiments also show us that breakdown tests are wrong? If a cable or other apparatus successfully withstands a breakdown test, it is supposed to be more reliable than one that has not been subjected to the same test. Yet a glance at the action of the current on the stick

or the glass will show that such a test as that, for instance, if applied for any sensible time, must seriously weaken the insulating properties of the material experimented upon. The insulation may not be broken down, because the strain is not kept up long enough, but the material is not the same as it was before the test is applied, and has not the same power to resist the passage of leakage due to even low tensions as before. A strip of rubber, if stretched only slightly, may be strained hundreds of times, and will always go back to its original form, or nearly so, but once stretched beyond a certain limit, the strip never comes back to its old form again.

In the writer's opinion, there is only one form of test that is of value for any apparatus—viz., a close imitation of the actual conditions of working, carried on for a long period of time, with possibly a slight increase in the strain applied, above the normal working conditions. This, supported by close and persistent observation of the apparatus in actual work, gives us real experience of the highest value. But the importance of such experiments as those shown by Messrs. Siemens can hardly be exaggerated as an aid to our experience. They enable us to see visibly, going on, what a careful study of principles and observation of results have taught us to imagine as going on, though hidden from our view.

PRACTICAL INSTRUMENTS FOR THE MEASUREMENT OF ELECTRICITY.

BY J. T. NIBLETT AND J. T. EWEN, B.SC.

VI.

(Continued from page 302, Vol. IX.)

RESISTANCE, *continued.*

Wheatstone's Bridge (continued). The original form of Wheatstone's Bridge consists essentially of a stretched piece of uniform high resistance wire, (N)(M) Fig. 5, about one metre long, from which it derives its name, the *Metre Bridge*

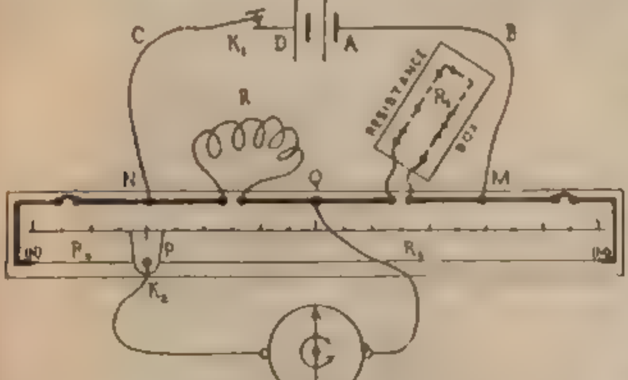


FIG. 5.—Diagram showing Single Wire Metre Bridge and Connections.

A contact maker, P, which really constitutes the key of a sensitive galvanometer, is made to slide up and down along the wire and in front of a calibrated scale, so as to vary the lengths, and correspondingly the resistances, of the portions R_2 and R_3, of the stretched wire on either side of it, the relative values of these two resistances being read off from the calibrated scale. A broad strip of copper, (N) N Q M (M), whose total electrical resistance is quite negligible, is laid along the base-board of the Bridge, and completes the apparatus. This copper strip is furnished with binding screws and removable portions as shown, to permit of the insertion of R, the coil whose resistance is to be determined, and R_1, a known variable resistance which usually takes the form of a plug Resistance Box or a calibrated Rheostat. Besides these, one or more additional known resistances are sometimes introduced into the circuit in special cases, to increase the accuracy of the readings. At the points N and M are binding screws for connecting up the battery circuit, which consists of a battery D A, of a fairly constant type such as a Daniell, and a contact-maker K_1; and at the points P and Q are screws for connecting the galvanometer circuit, which consists of a sensitive high resistance galvanometer (such as a Thomson, Deprez, or D'Arsonval reflecting instrument, some form of zero instrument, or even a telephone receiver), and the sliding contact-maker P, which fulfils the function of the galvanometer key K_2.

In this, as in all other forms of the Wheatstone's Bridge, the battery circuit and the galvanometer circuit may be interchanged, without in the slightest degree affecting the principle of the apparatus or influencing the results obtained, but the arrangement shown in Fig. 5 (in which the sliding contact-maker P forms the galvanometer key and not the battery key) will be found the more convenient of the two for ordinary measurements.

FIG. 6. Single-Wire Metre Bridge.

Fig. 5 shows diagrammatically the *Single-Wire Metre Bridge* in its simplest form, with all its connections made in readiness for measuring a resistance, and the commercial form of the instrument as sold and used is illustrated in Fig. 6.* A more elaborate form of the instrument, known as the *Five Wire Metre Bridge*, in which the single wire (N)(M), is replaced by a long wire stretched five times from side to side, and which is therefore capable of much more accurate work than the single-wire instrument, is illustrated in Fig. 7*; and other forms have been constructed with a considerably greater number of wires than this.

In Figs. 5 and 6 it will be seen that besides the two removable pieces for the insertion of R and R_1, there are two other places, one between M and (M), and the other between N and (N), where the circuit may also be interrupted and additional resistances inserted. When these additional resistances are used, they have to be added to the resistances of the adjacent portions of the stretched wire, in determining the value of an unknown resistance. In this case, therefore, it is necessary to know the actual resistance of the stretched wire in order to arrive at the value of the ratio $\frac{R_3}{R_2}$. It is often desirable to make measurements with these auxiliary resistances thrown in, so as to obtain the value of the resistance R to a greater degree of accuracy. This method of measuring resistances is illustrated in Example 2.

The total resistance of the wire in a Single Wire Metre Bridge is usually about five or six Ohms, although in special cases it may be increased to many Ohms, or reduced to the fractional part of an Ohm. The wire is usually made of German silver, platinoid, phosphor bronze, or silicon bronze for fairly high resistances, and of silver or copper for very low resistances.

FIG. 7.—Five Wire Metre Bridge.

As ordinary commercial wire is found to vary somewhat in its electrical resistance throughout its length, instead of dividing off the scale into exactly equal divisions from end to end, it is advisable to calibrate the stretched wire between its two ends, marking off the scale in such a way that the scale divisions portion off the stretched wire into small parts of equal resistance. The principle on which this is done is somewhat analogous to the method of cali-

* Figs. 6 and 7 are examples of Single Wire and Five Wire Metre Bridges, as made by Messrs. Nalder Bros., London.

brating a thermometer tube in order to compensate for slight variations in the bore of the tube.

Example 1. In Fig. 5, suppose that the apparatus has been fitted up as shown, for measuring the resistance R of a coil of wire; and that the plugs removed from the resistance box, are respectively 40, 20, 10, 4, 3, and 1, so that R_1 is equal to 78 ohms. Then if the galvanometer spot indicates no deflection when the sliding contact maker is just in the position shown, the value of R, the resistance which is being measured, will be found as follows:

$$R = R_1 \times \frac{R_2}{R_3},$$
$$= 78 \times \frac{20}{80},$$
$$= 19{\cdot}5 \text{ Ohms.}$$

The total resistance of the coil is therefore equal to 19·5 Ohms.

Example 2. As in the previous example, let the bridge be connected up as shown in Fig. 5, with the addition that the removable piece between N and N_1 is taken out and a coil whose resistance is 60 Ohms is inserted in the gap, and that a coil of 30 Ohms resistance is inserted in a similar manner between M and M_1, the total resistance of the stretched wire having been found to be exactly 8 Ohms. Then when the plugs 100, 40, 30, 3, and 1 have been removed from the resistance box, and the sliding contact maker P has been brought to the position shown, if the galvanometer shows no deflection, the resistance of R will be found as follows:

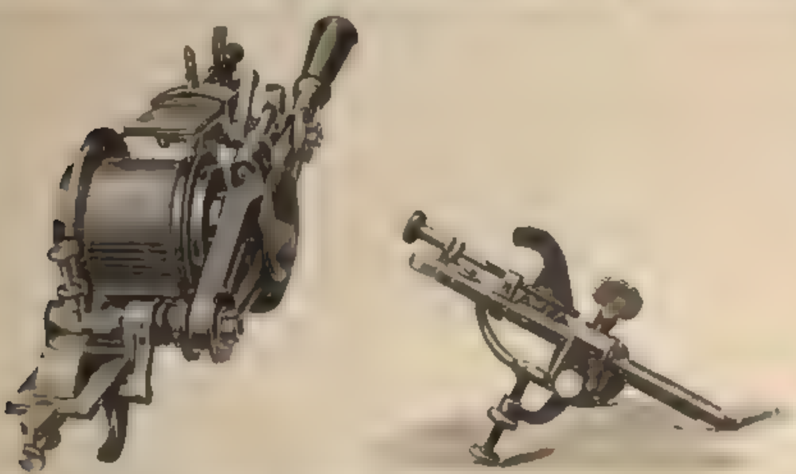
$$R_1 = 100 + 40 + 30 + 3 + 1 = 174 \text{ Ohms.}$$
$$R_2 = 30 + 8 \times 0{\cdot}6 = 34{\cdot}8 \text{ ,,}$$
$$R_3 = 60 + 6 \times 0{\cdot}2 = 61{\cdot}2 \text{ ,,}$$
$$R = R_1 \times \frac{R_3}{R_2},$$
$$= 174 \times \frac{61{\cdot}2}{34{\cdot}8},$$
$$= 306 \text{ Ohms.}$$

The total resistance of the coil is therefore equal to 306 Ohms.

(To be continued.)

TRADE NOTES AND NOVELTIES.

The Newton Electrical Company, of Taunton, have some very convenient pieces of apparatus for installation work well worth the attention of electrical engineers. One of these is their patent adjustable brushholder, which we illustrate herewith.



Newton Adjustable Brushholder.

A difficulty with brushes is that they require shifting when the dynamo is running, and with the usual type of brushholder this is sometimes a difficult or ticklish operation. With the Newton brushholder the copper gauze is carried in a holder sliding in a slot, with a screw attachment. To alter the lead of the brushes, or allow for wear, all that is necessary to do is to turn the milled head, which is easily reached, quite away from the brush itself. The brush can be altered to any position of least sparking with the utmost ease. The holder has also a cam arrangement for raising or lowering the brushes to the commutator with a single simple motion of a catch handle. The whole brushholder is ingenious and effective.

The other piece of apparatus shown is an automatic cut-out for charging accumulators. The principle is the combination of two hollow magnetic shells whose polarity is changeable by alternation of the current. When the dynamo is started and the E.M.F. rises sufficiently the lower magnet is excited, and the attraction causes a slight movement and the contact seen to one side throws the cells into circuit. This also puts the main circuit through the upper magnet, making it of opposite polarity to the lower magnet, giving, therefore, strong attraction as long as the main current is going into the cells. When the E.M.F. of the cells rises sufficiently, or when the E.M.F. of the dynamo falls, the current in the main circuit reverses, coming out of the cells, and the polarity of the upper magnet is immediately changed, repelling the lower magnet, and thus breaking the circuit. Their charging cut-out is very sensitive, and acts very satisfactorily. The sensitiveness is adjustable by a thumb set screw.

Newton Automatic Charging Cut-out.

BLACKPOOL.

The following is the report of the Committee on Electric Lighting:

In pursuance of the resolution passed by the Electric Lighting Committee on the 20th November, 1891, and confirmed by the Council on the 1st December, 1891, the following members of your sub-committee — viz., Mr. Councillor Pearson (chairman), Mr. Alderman Cardwell, and Messrs. Councillors Sergenson and Smith — beg to report as follows:

Accompanied by the borough surveyor, they visited Bradford, Huddersfield, London, Chelmsford, Fareham, Eastbourne, Brighton, Deptford, and districts near London, with the object of inspecting the various systems of electric lighting, and obtaining the fullest authentic information as to the commercial success or otherwise which has attended the application of electricity for lighting and general industrial purposes at these places.

The above-mentioned members of the sub-committee, together with the Mayor and Mr. Councillor Nickson, visited Huddersfield on the 16th December and Bradford on the 17th December, 1891. They were informed that the Corporation of Huddersfield had entered into a contract with the Brush Electric Lighting Company to instal the borough with both public and private lighting, the principle to be adopted being the high-tension alternating current system. The Corporation had not appointed an electrical engineer, but the subject was under consideration, and the Corporation are now applying for powers to borrow £50,000.

At Bradford your sub-committee found that a most extensive and complete installation of incandescent lighting had been inaugurated on September 20, 1889, on the principle known as the low-tension continuous-current system. The installation has been designed for the Corporation, and superintended during erection by their electrical engineer, Mr. James N. Shoolbred, of Westminster, and the whole of the electric plant, including dynamos, cables, electric instruments, and appliances of all kinds for the regulation of the current have been constructed and laid by Messrs. Siemens Bros. and Co., of London, all the streets being opened and made good by the Corporation. The average distance from the station to the area of supply is about 1,000 yards, and the largest cable used has a sectional area of 0·8 of a square inch of copper. The storage room contains 65 accumulators by Crompton and Co. These accumulators keep up the supply from 10.30 p.m., when the engines are shut down until about 11 a.m., when smaller engines are started. The number of customers supplied is about 150, requiring some 16,000 lamps each of 8 c.p., the demand being confined almost entirely to large warehouses, clubs, offices, hotels, and shops. The engineer to the Corporation, as well as the customers, admit that the cost is twice double that of gas, yet the latter are content to continue the use of electricity for lighting purposes, recognising fully its decided advantages over gas. The price charged is 6d. per Board of Trade unit; the capital invested is about £35,000, and the annual revenue about £4,000; the sinking fund being calculated as for a repayment in 30 years. The price of gas charged in Bradford is 2s. 3d. per 1,000ft., the Corporation being owners of the gas works as in Blackpool. Your sub-committee were received with the greatest courtesy by the Mayor, the town clerk, etc., and Mr. W[illegible], assistant electrical engineer to Mr. Shoolbred, manifested every disposition (in acting as conductor over the central lighting station) to put them in possession of the fullest and most reliable information with regard to their installation.

the side streets by 222 incandescent lamps, of 32 c.p. The current is carried by means of overhead cables, and the high tension alternating current system is employed.

The whole of the plant has been laid down and the complete installation carried out by Messrs. Crompton and Co., to whom the Town Council, who have abandoned gas altogether, pay £22 10s. for each arc lamp, and £2 6s. 10d. for each incandescent lamp per year, the lights to burn from sunset to sunrise all the year round. Messrs. Crompton's electricity works at Chelmsford were inspected, and through the courtesy of Mr. Albright some exceedingly interesting exhibitions of the manufacture of dynamos, arc lamps, and other electrical appliances were witnessed. Messrs. Crompton were also invited to interview the full committee at Blackpool, and to specify and tender for the installation of the borough. Several interviews have been held, and a specification and tender have been received from them.

Your sub-committee having thoroughly examined the Thomson-Houston system (especially as regards street lighting), and witnessed the same subjected to the severest tests, then resolved to inspect for the purpose of comparison the central stations, plant, and system of working (both arc and incandescent lighting) of the Brush Electrical Engineering Company. They therefore placed themselves under the conduct of Mr. Sellon and Mr. Raworth, the engineers and joint managers of the Brush Company, and proceeded to inspect their central station at Meredith Wharf, Bankside, Lambeth. At this large station all the current necessary to instal the western half of the City of London, as per this company's very large contracts with the Commissioners of Sewers, for both arc and incandescent lighting is generated. The high tension alternating current system is employed for the incandescent lighting, and the low tension continuous current by separate dynamos for the arc lighting, and with the exception of the boilers, which are Babcock Wilcox, all the machinery, including engines, dynamos, exciters, etc., are manufactured by the Brush Company, and are their own patents. Queen Victoria-street, which is lighted from this station by 26 arc lamps, each of about 2,000 c.p., placed 45 yards apart, diagonally, is one of the best lighted thoroughfares in the country, and affords an excellent example to compare with King William-street, which is illuminated by Thomson-Houston lamps of similar power. The lighting of these Brush Company's lamps costs £26 per annum each, and the lamps are lighted from dusk to dawn. The Brush Company's electrical works at Lambeth were also visited, and an inspection was made of their special exhibits of the latest types of electrical appliances and machinery at the Crystal Palace, where Mr. Garcke, the managing director for the Brush Company, courteously received your sub-committee, and, together with Mr. Sellon and Mr. Raworth, gave them every information regarding the object of their visit. The experience of this company is that the average cost to "wire" a house or shop is about 20s. to 25s., and they charge for the supply of current to consumers in London 7½d. per Board of Trade unit. The Brush Electrical Company were also invited to interview the full committee at Blackpool, and to specify and tender for the installation of the borough. Several interviews have been held, and a complete specification and tender have been received from this well-known manufacturing company.

The Chelsea Electricity Supply Company's system is a combination of moderately high pressure direct current, using accumulators and direct current transformers for low pressure discharge. Their central station at Draycott-place, Chelsea, was found to contain a vast number of accumulators, and a continuous current transformer, so that lamps in the neighbourhood could be lighted either from the dynamos direct, or from both, simultaneously. The mode of distribution employed is, that currents of moderately high pressure (from 500 to 1,500 volts) are distributed by a charging main to sub-stations at convenient distances throughout the district. Storage batteries are placed in these sub-stations, which, after being charged from the high pressure mains, are then switched on to the low pressure lamp service. There are 1,250 houses and shops in the company's district of Chelsea, and out of this number the company have on their books about 300 consumers, taking current for the supply of about 22,000 8 c.p. lamps, or its equivalent. They have rarely more than 10,000 lamps in use at any time. Willans and Robinson engines, Babcock Wilcox boilers, Elwell Parker's dynamos, and continuous current transformers, and the Aron meters for measuring, are in use at this station.

Another district visited which is successfully installed by this combination of high and low pressure and storage batteries, is the Sydenham and Crystal Palace District Company's area, and their system and financial prospects were fully enquired into, with the assistance of their manager, Mr. Geo. Offor. By adopting high-pressure mains this company is now enabled to supply about 500 h.p. of electrical energy, and to transmit the same to the Crystal Palace for the purposes of the Electrical Exhibition. The price charged to consumers by this company is 8d. per Board of Trade unit, this price being equal to about ¼d. per 8 c.p. lamp per hour. The same types of machinery are used as at Chelsea—Babcock Wilcox boilers, Willans and Robinson engines, Elwell Parker dynamos, and King's patent continuous current transformers.

The Westminster Electric Supply Corporation's central station at Millbank-street was visited by your sub-committee, accompanied by Mr. Sharpe and Mr. Kent, electrical engineers of Westminster, who introduced the deputation to Prof. Kennedy, the consulting engineer to this electric company. This central station was found to be so well arranged that, in the committee's judgment, none of the stations which had been inspected excelled, and very few equalled, it in general appearance and the symmetrical arrangement of all the machinery. The method of working is a direct current storage one, and the mains are laid on the three-wire system. The total number of lights connected to the mains of the Westminster Company is about 70,000 8 c.p., and of these about 25,000 are run at full load. The company have three central stations—one at Eccleston-place, Belgravia; one at Davies-street, Mayfair; and the one at Millbank-street; and by an arrangement which has been made for supplying all the lights off a main ring, to which all the stations are connected, the current is supplied from all these three stations. In the Millbank-street station there are five boilers by Babcock Wilcox, eight engines by Willans and Robinson, five dynamo machines, two by Mather and Platt, and three by Goolden and Co., and complete condensing apparatus was put down, and was in daily use. Two switchboards are fixed, one at either end of the room, the larger one being for the general supply system, and the smaller one for the Houses of Parliament. The latter is quite distinct from the other circuit, no other lights being controlled by it than those installed in the Houses of Parliament. The switchboards are both by Messrs. Crompton and Co., Limited. The accumulators employed are the Crompton-Howell, the present plant consisting of three sets or batteries, each set having 54 33-plate cells. The meters used are the Aron instruments of the improved type; Messrs. Sharpe and Kent were the contractors for the installation of this station and plant.

Another important installation which your sub-committee visited was at Brighton. This is also worked on the low pressure continuous current system, and is owned by the Corporation of Brighton. The deputation received all courtesy and information respecting the central station, and the supply of the current, etc., from the Mayor, who was accompanied by Mr. Talbot, the deputy town clerk, Mr. Wright, the resident electrical engineer, Mr. Nebel, the superintendent of works, and several members of the Council. The Corporation have already expended £43,000 on the installation, and they are now seeking powers to extend their area of supply, which will necessitate a further considerable outlay for extra plant for sub-stations, etc. The present station will supply 10,000 lamps of 8 c.p. for incandescent lighting, no arc lighting being attempted by the Corporation for street lighting. Their borrowing powers extend for a period of 30 years, and they are now applying for a supplementary loan to extend over the same period. They are supplying about 4,000 lamps with current, and their charge is 7d. per Board of Trade unit, the number of lamps lighted at any one time being 2,000, and their largest customer is the Alhambra, which is installed with over 300 lamps. This is considered to be very good business for the short time in which they have been running (about four months only), and, of course, no profit or loss can as yet be estimated, though the mayor expressed his opinion that loss must arise on the present output, but that if the maximum current be supplied a profit may be made, as the only increased outlay will be in the direction of wages and coal. The Brighton Lighting Committee consider their low pressure continuous current and storage battery system the best for compact districts with plenty of consumers. The Council recommend strongly the keeping of the electric lighting order in the hands of the Corporation, and have great faith in the future development of the electric light. Your sub-committee learned here, as in Bradford, that, lamp for lamp, the electric light costs the consumers about double the price of gas, but the consumers' expectations were more than realised by the improved condition of health and cleanliness, smaller fire risks, clearer atmosphere, a better light, and the absence of destructive effect as the result of the electric lighting ... gas. Your sub-committee were informed that consumers were all satisfied and their number was rapidly increasing. About 20 miles of cable have been laid in small subways under the footpaths, and the compulsory area in question is about a square mile. The plant consists of three Lancashire boilers ... acting as a stand-by, with space for three additional boilers; three compound direct coupled engines, by Willans and Robinson, each developing 98 i.h.p. at 450 revolutions. The dynamos, electrical apparatus, etc., are all by Siemens Bros., and Goolden and Co. Several descriptions of meters are in use, ranging from [illegible] to 100 lights, the Aron (prime cost £5) being hired out at [illegible] a year, the Corporation keeping all meters in repair. The working hours at the station are from 2 p.m. to 10 p.m., when steam is shut off, the batteries supplying current for the remaining 16 hours. The price of coal at Brighton is 22s. per ton and the charge for gas is 2s. 9d. per 1,000 cubic feet. Brighton is also possessed of another system of distribution, which is competing keenly with that of the Corporation for the lighting business of the borough. This installation belongs to the Brighton and Hove Electric Light Company, and is worked on the high pressure alternating current system, and without the aid of storage batteries. Messrs. Hammond and Co. were the engineers and contractors for this company, and Messrs. Hammond's London manager, Mr. Goodle, and Mr. Hodgson, the manager for the Brighton and Hove Company, conducted your deputation over the central station and plant, and supplied the following information to them. The capital of the company is only £17,500, and they can, with their plant, serve the whole of the area of Brighton, including the area served by the Corporation, their wires being laid now at a distance of over [illegible] miles from the station. At the time of your sub-committee's visit 10,000 8 c.p. lamps were running, this number showing an increase over the year 1890 of 3,319 lamps. The cost of the mains for the Corporation supply was over £18,000, whereas the company's mains only appear in their books at £5,000. This item of mains is one of the principal differences in cost between the high and low tension systems. The company further claim that by the use of the high pressure system the excessive waste connected with the use of accumulators is avoided, as well as the heavy cost in mains. The company charge 7d. per Board of Trade unit in the area within which they compete with the Corporation, and 8d. outside. The total length of mains laid is about 12 miles, covering nearly

the whole of Brighton and Hove. Mr. Hammond is the chairman of the company, and they have paid 5 per cent. dividend on their capital for several years.

Eastbourne: Messrs. Hammond and Co. were also the electrical engineers and contractors for the Eastbourne Electric Light Company, which is stated to have been the first company in England to supply electrical energy for both public and private lighting from a central station. The capital of the company is £28,000, and they pay 6 per cent. for their debenture capital. The system used is the high-pressure alternating current of 1,800 volts at the central station, which is transformed by means of Lowrie Hall converters down to about 100 volts before entering the consumer's premises. This company supply the Corporation of Eastbourne with the arc lighting for the Promenade. A special engine drives a Brush dynamo for this lighting alone, starting an hour before sunset and closing at 11.30 p.m. This public lighting of the Promenade consists of 16 Brush arc lamps of about 2,000 c.p. each, and each lamp costs the Corporation 3½d. per hour, or a total for the whole of the lamps of £480 per year. The station is supplying about 4,000 incandescent lamps of 16 c.p. out of a total capacity of 6,000, and the charge to consumers is 10d. per Board of Trade unit. Coal costs about 26s. per ton. The plant consists of Fowler's tubular boilers, Fowler's 150-h.p. compound engines, driving Elwell-Parker dynamos by belting. Westinghouse meters are used, and are hired out to customers at 5s. per quarter.

West Brompton: This is another central station and installation for which Messrs. Hammond and Co. were the electrical engineers and contractors. The capital of the West Brompton House-to-House Electric Company is £70,000, and the company was formed in 1879. Of all the stations visited by your sub committee, this was the best example for working the high tension alternating-current system by means of converters which came under their notice. Mr. Gay, the engineer and manager, with Mr C. P. Goode, the manager for Messrs. Hammond and Co., conducted the deputation over the station, and courteously and lucidly explained the system under which they were working, and supplied the fullest information as to cost of working and the power of the plant, etc. There are about 22 miles of mains laid in cast-iron pipes of 6in. diameter for the largest size. Four Babcock Wilcox boilers, working up to 120lb. pressure; four Fowler compound engines (non-condensing), one of which, of a small size, works after 12 p.m. The dynamos were of the Lowrie-Hall type, being manufactured by Messrs. Elwell and Parker, and were driven by ropes from grooved flywheels of engines. At present there are about 26,000 lamps installed, the greatest number lighted at one time being about 10,000. The station is so designed that it can be extended at any time to hold 12 engines and dynamos capable of supplying 40,000 lamps. Westinghouse meters are used, and are hired out to consumers at 5s. per quarter, and the charge made for current is at the rate of 8d. per Board of Trade unit. The engineers laid great stress upon the advantages to be gained by adopting the high tension system for a place like Blackpool, and strongly emphasised the fact that all danger is removed by this system by the employment of converters which deliver the current to the consumer at about 100 volts only. The smooth, almost noiseless working of this station; the admirable and convenient arrangement of all apparatus and machinery; the apparently highly successful system of generating and supplying electric light and power by means of the Lowrie-Hall types of alternating-current high-pressure dynamos, which are worked in parallel, and are not affected by the extinction or relighting of large numbers of lamps; the absence of all complicated machinery or instruments, together with the well-considered and exceedingly simple arrangements of the switch and testing rooms, and the satisfactory supply and steadiness of lights to consumers, powerfully and favourably impressed your sub-committee as being in every respect not only a model station but one displaying in the clearest and simplest form a system calculated to meet in an eminent degree the peculiar requirements of both public and private lighting, as well as the supply of electric motive power, for Blackpool. Messrs. Hammond and Co., engineers to the House-to House Electric Supply Company, of London, Leeds, Dublin, Coatbridge, Burton, The Scotch, etc., were invited by your sub-committee to visit Blackpool, and to specify and tender for their system of installation for the borough. Accordingly several interviews have been held by the full committee with this company, at which there have been present Mr. Robert Hammond (the well-known electrician) the principal of the company, Mr. Goode, the manager, and Mr. Hall, the chief electrical engineer, etc., and a detailed specification of their Lowrie-Hall system, together with a tender for the complete installation of the borough, have been furnished to the committee.

The sub-committee with the knowledge gained by the enquiries before named, and having had the advantages of the conferences between several electrical engineers and the full committee, and also having regard to the following considerations, have now arrived at the recommendations hereinafter set forth. The considerations which the sub committee have had in mind are:

That the Corporation are themselves the undertakers for the purposes of the Blackpool Electric Lighting Order, 1890; that the borough, which is the prescribed area of supply, is sparsely occupied in some portions, whilst in other places at long distances apart there are many streets, houses, and buildings likely to be required to be lighted by electricity; that an installation in any particular part of the borough may soon have to be extended so as to embrace a wider district of actual supply; that any area of supply in Blackpool is necessarily, owing to local conditions, irregular in form and not compact, and that for the present the consumers therein must, until the supply has been in use, and the cost to such consumer experienced, be at uneven distances apart; that in the only streets wherein under the order distributing mains are to be laid within a definite time, there is an existing installation in the form of the Marine Promenade electric lighting; that any installation should be adapted for permanent and economical working; that in carrying out any scheme regard should be had to as small a burden in the way of loans and repayment as would be consistent with efficiency and provisions for future development; that the question of street lighting in the business parts of the town must be taken into account; that apprehensions of danger from adoption of a high-pressure system must be borne in mind, and such apprehensions shown to be groundless; that it may now be assumed that the adoption of electricity as a means of public and private lighting has passed its initial or experimental stage; and that on grounds of utility, health, and attraction, the Council may now safely be recommended to undertake a supply of electric energy for such lighting in Blackpool.

The sub-committee therefore respectfully submit the following recommendations and opinions for approval and adoption:

1. That the Corporation should not transfer their powers and works under the order to any company or person, but keep the same in their own hands and control, and should employ electrical contractors to execute for the Corporation any necessary works.

2. That the best system to meet the scattered and uneven collections of probable consumers, and bearing in mind the long distances many of them will be apart, will be the high-tension alternating-current transformer system. This system, in the sub-committee's opinion, is best calculated to meet the growing requirements of such a town as Blackpool, and of further reasonable extensions without much additional expense at the central generating station, and without the necessity of providing any substations, and would also be best suitable for districts which are not compact in themselves, or where the separate consumers therein may be wide apart.

3. That the central generating station might advantageously be erected on land belonging to the Corporation at the central storeyard.

4. That the high tension alternating current system can more successfully deal with the Promenade and public street lighting than the low-tension continuous-current system, and the sub-committee consequently recommend the discontinuance of the present low-tension system of electric lighting on the Promenade and piers.

5. That for the Promenade and piers the sub-committee recommend a greater number of arc lamps than the number now in use, and that each lamp be of 2,000 c.p. instead of the present 6,000-c.p. lamps, and that same be placed at less distances apart, and on shorter and ornamental poles not exceeding 25ft. in height, in lieu of the existing 60ft. poles, as being calculated to give far more efficient illumination, and a much more even distribution of light, and at a considerably reduced cost; thus adding an additional artistic and attractive feature to the Marine Promenade. The sub-committee further suggest the same power and height of lamp for street electric lighting in those parts of the borough which the Council may determine to have lighted by electricity.

6. That the capital expenditure required for the system which the sub-committee suggest is estimated to be very much less than for the capital expenditure of any other known system. Moreover, the sub-committee believe its working would be more economical, more efficient, and better adapted for future development than the other systems.

7. That the high-tension system does not present dangerous features, because by the use of transformers the high-pressure electric current is converted into a low-pressure and harmless current before entering the premises of one or more consumers.

In conclusion, and feeling that the Council and the public, upon whom the support of any new system of lighting must depend, will expect an expression of opinion as regards the probable capital cost, and the expense to the consumer himself, the sub-committee report that they believe a capital outlay of about £26,000 would satisfactorily meet the present requirements of those parts of the borough where electricity may be demanded, either for lighting purposes or motive power, and that electric energy by the system recommended by the sub-committee can, after making provision for sinking fund and interest, be supplied to consumers at a charge not greater than 6d. per Board of Trade unit, possibly at 5d., and that if there be a fair increase in the consumption the charge may even be less than 5d. A charge of 6d. per Board of Trade unit would be equivalent to a charge of about 4s. per 1,000 cubic feet of gas of 18 standard candle-power.

Before advising the final acceptance of the particular tender recommended by the sub-committee, it is desired that the Council should first approve of the system suggested, and that in place of obtaining a report from a consulting electrical engineer as already authorised by the Council, the Electric Lighting Committee should be empowered to appoint a resident electrical engineer to advise on the specification and tender recommended by the sub-committee, and that such resident electrical engineer should have charge of the works during construction and of their subsequent maintenance.

The sub-committee venture to express the hope that their long and arduous enquiries and labours will be satisfactory to the Council and lead to the further development of the attractions and prosperity of the borough, both as a growing health and pleasure resort, and also as a residential town, by a more general adoption of electricity as a healthy and non-injurious illuminant.—On behalf of the sub-committee, JAS. PEARSON, Chairman.

29th June, 1892.

At the Council meeting last week the following report of the Electric Lighting Committee was adopted, the only question dis-

caused being the amount of the salary of the resident electrical engineer.

"Resolved that subject to revision of the specification by the Corporation's resident electrical engineer to be appointed as recommended by the sub-committee, the tender No. 2, now before this meeting, for carrying out the works advised by the sub-committee be recommended to the Council for ultimate acceptance. That the town clerk be instructed to apply to the Board of Trade for the Board's approval of the high-tension alternating current system for the supply of electrical energy by the Corporation within the borough, under the Blackpool Electric Lighting Order, 1890, and that all necessary plans and particulars be furnished to the Board. That a resident electrical engineer be appointed as recommended by the sub-committee, and that the approval of the Council be an authority to this committee to appoint such an engineer, at a salary to be fixed by the committee. That the Finance Committee be desired to direct an application to the Local Government Board, under the Electric Lighting Acts, and the Public Health Act, 1875, for the sanction of the Board to the borrowing by the Corporation, as the urban sanitary authority for the borough, of the sum of £26,000, repayable in 30 years, for the purposes of the Blackpool Electric Lighting Order 1890, on security of the District Fund and General District Rate, and any property of the Local Authority."

LEGAL INTELLIGENCE.

JOEL v. BARNET LOCAL BOARD.

The following is the text of the award, the general purport of which we have previously given.

"To all to whom these presents shall come. We, John C. Fell, of 1, Queen Victoria-street, in the City of London, civil engineer and patent agent, and John Slater, of 46, Berners-street, in the county of London, architect, send greeting. Whereas, by a memorandum of agreement, made the 6th day of July, 1888, between Henry Francis Joel, of 31, Wilson-street, Finsbury, in the county of Middlesex, electrical engineer, of the one part, and the Barnet Local Board of the other part, it was agreed that the said Henry Francis Joel should carry out a system of electric lighting within the district of the said Barnet Local Board upon certain terms therein mentioned, and it was among other things provided therein that if any dispute should arise under the said agreement the same should be referred to the arbitration of two arbitrators and an umpire in the usual way, and that the said agreement might be made a rule of court at the instance of either party. And whereas divers disputes arose under the said agreement, and in pursuance of the aforesaid provision on that behalf the said Henry Francis Joel thereupon (with the concurrence of the Barnet and District Electric Supply Company, and Thomas William Potter, who had become, or claimed to have become interested with the said Henry Francis Joel under the said agreement), did, by writing under his hand upon the 26th day of March, 1891, appoint me, the said John C. Fell, as his arbitrator to settle and determine the said disputes, and the said Barnet Local Board did, by writing under their seal on the 8th day of April, 1891, appoint me, the said John Slater, as their arbitrator, to settle and determine the said disputes. And whereas we, the said John C. Fell and John Slater, before we entered upon the matters so referred to us did on the 21st day of July, 1891, by writing under our hand, duly nominate and appoint Lumley Smith, Esq., one of H.M. counsel, to be the umpire in the matter of the arbitration, and the said umpire, with the consent of ourselves and the other said parties, and at the request of the said parties, was present when we heard the said parties and their witnesses during the said reference. And whereas for the purposes of the said arbitration and our determination therein, the said Henry Francis Joel delivered to us and to the said Barnet Local Board particulars in writing of divers breaches of the said agreement which he alleged to have been committed by the said Barnet Local Board, and the said Barnet Local Board also delivered to us and to the said Henry Francis Joel particulars in writing of divers breaches of the said agreement which the said Barnet Local Board by way of defence and consideration, alleged to have been committed by the said Henry Francis Joel, and such particulars so delivered by the said parties respectively as aforesaid were adopted by the said parties as defining the matters in respect of which our determination was desired. And whereas the said parties to the said reference at the hearing thereof concurred and agreed that it should not be necessary for us, the said arbitrators, by our award to settle or determine all or any of the other disputes or alleged breaches separately or specifically, but that we might give our award generally for the one party or the other upon the whole of the said matters of dispute and alleged breaches taken together. And, whereas, on the 23rd day of May, 1892, by a judge's order of the Queen's Bench Division of the High Court of Justice, the time for us, the said arbitrators, to make our award was enlarged until the 15th day of July, 1892. Now we, the said arbitrators, having taken upon ourselves the burthen of the said reference, and having heard the said parties and their witnesses, do hereby make and publish our award in writing of and concerning the matters above referred to us in manner following, that is to say, we award and determine that the said Henry Francis Joel is entitled to recover from the said Barnet Local Board the sum of £500, which sum we award and direct that the said Barnet Local Board do pay to the said Henry Francis Joel. And we further award and direct that the said Barnet Local Board do pay to the said Henry Francis Joel his cost of the reference and also pay the costs of the award, and that the said Barnet Local Board do bear their own costs of the same. In witness whereof we have hereunto set our hands this 29th day of June, 1892. (Signed) JOHN C. FELL, JOHN SLATER."

COMPANIES' MEETINGS.

LIVERPOOL OVERHEAD RAILWAY.

A special general meeting of the shareholders of the Liverpool Overhead Railway Company was held on Tuesday, Sir W. B. Forwood presiding.

The meeting was called to rescind a resolution passed on February 9 last, and to pass another one increasing the amount it was proposed to raise for carrying on the work of constructing the railway. **Mr Allsopp**, the solicitor to the Company, in explaining the clause of the Act of Parliament under which shareholders met, said by the original Act incorporating the Company, passed in 1888, the capital of the Company was fixed at £450,000, and its borrowing powers at £150,000. The borrowing powers were subject to the restriction that nothing at all could be borrowed until half of the capital had been issued, and then only £75,000, and after that nothing more until the whole of the capital had been issued. By the Act of Parliament passed during the present year the borrowing power was varied, and it was provided that as regarded £375,000 of the capital one third should be borrowable—namely, £125,000—if the shareholders sanctioned it.

The **Chairman** said originally it was expected the railway would cost £450,000, which was made up of £375,000 share capital and £75,000 of bonds. Originally it was intended that the railway should be worked by steam locomotive power, but it had since been determined, and he thought very wisely determined, by the Directors, and sanctioned by the shareholders, that they should adopt electricity in place of steam. The result was that instead of paying £37,000, which was the estimated cost of their steam plant, they would have to pay about £67,000, the estimated cost of the electrical plant—an increase of £30,000. From the investigations they had made, they believed that the increase was fully justified, as they were likely to save nearly 20 per cent. per annum by working their railway by electricity instead of steam. An item growing out of the adoption of electricity was the question of electrical automatic signalling, which would cost £11,000, as compared with £3,000 required for the ordinary hand signalling. Although the first cost was greatly enhanced, the cost of working the signals would be very considerably decreased. They would be worked automatically, and the saving in manual labour would be very large indeed. It would perhaps interest the shareholders to know that although the progress with the railway had been much slower than they anticipated—they had encountered as every new undertaking encountered very many unforeseen difficulties—they were now approaching the completion of the work, and they thought they could see their way clear to having the railway in active operation in October next. They had only 48 spans of the main structure to place in position, and the electric station at the Wellington Dock was almost completed. He moved that the resolution passed at the general meeting of the shareholders, held on the 9th February, 1892, authorising the Company to raise the sum of £75,000 by the creation and issue of debenture stock for that amount be rescinded.

Mr. Richard Hobson seconded the resolution, which was carried.

The **Chairman** then moved that the Liverpool Overhead Railway Company, in exercise of the power conferred by the Liverpool Overhead Railway Act, 1892, be authorised to raise the sum of £125,000 by the creation and issue of debentures for that amount, and that accordingly the Directors be authorised to issue such debentures, at such rate of interest, in such amounts and manner, at such times, and on such terms, as they might think fit.

Mr Hobson seconded, and the resolution was also carried, and the proceedings terminated.

COMPANIES' REPORTS.

ELECTRICAL POWER STORAGE COMPANY, LIMITED.

Directors: John Irving Courtenay, Esq. (chairman and managing director); Sir Daniel Cooper, Bart., G.C.M.G.; James Balfour, Esq.; Frederick Green, Esq.; James Pender, Esq. Manager: Frank King, M.I.E.E. Secretary: J. W. Barnard.

Report of the Directors, to be presented to the shareholders at the third ordinary general meeting, to be held on Wednesday, 20th July, 1892, at the offices of the Company, 4, Great Winchester-street, E.C., at 12.30 p.m.

The Directors have much pleasure in presenting to the shareholders the report and accounts up to 31st May, 1892. The gross profit and other sums receivable amount to £37,045. 12s. 2d. The Directors have made provision for maintenance of buildings, plant and tools, and depreciation, by writing off the sum of £1,401. 6s. 1d. The net profit, after payment of general expenses, management, etc., is £5,763. 11s. 9d., out of which the Directors propose to pay a dividend of 6 per cent. on the paid-up capital of the Company. This will absorb £5,017. 4s. 2d., and the remainder, viz., £746. 7s. 7d., the Directors propose to carry forward to next account. The Directors have during the past year completed the necessary arrangements for changing the name of the Company from the Foreign and Colonial Electrical Power Storage Company, Limited, to "Electrical Power Storage Company, Limited," thus restoring to the Company the prestige of the old E.P.S. name. During

the past 12 months the Company has acquired a lease of the storage battery manufacturing business previously carried on by the Electric Construction Corporation at Millwall and Wolverhampton, and included in this lease is the use of the plant, machinery, and, for a period of three years, of the stock existing at Millwall, where the business is now carried on. The accounts have been made up to 31st May, 1892, as at that date the lease of the manufacturing business from the Electric Construction Corporation, Limited, had been in existence 12 months. The shareholders will note with satisfaction from the profit above mentioned that the business of the Company exhibits marked vitality. The patents of the Company have been upheld abroad by legal decisions, which should have a beneficial effect upon the general business of the Company. The utility of secondary batteries for the work of central electric lighting stations, and the absolute necessity of such apparatus in private lighting installations being now generally admitted, the Directors are devoting attention to the commercial application of the secondary battery to electric traction. Very considerable success has attended the use of the Company's batteries for electric launch work. Some thousands of cells are, and have been, in use for this purpose during the past five years. Much activity exists among the various engineers, who are endeavouring to develop commercial methods of electrically propelling tramcars, omnibuses, and other vehicles, and the Company is in a position to profit by the successful result of their labours. The Directors are pleased to report that at the Crystal Palace Electrical Exhibition, 1892, the Company received the only gold medal for storage batteries. The retiring directors are Mr. Frederick Green and Mr. James Pender, who, being eligible, offer themselves for re-election. The auditors, Messrs. Broads, Paterson, and Co., also offer themselves for re-election.

BALANCE-SHEET, MAY 31, 1892.

Liabilities.	£	s.	d.	£	s.	d.
Capital authorised—20,000 ordinary shares of £5 each, and 100 founders' shares of £5 each	100,500	0	0			
Shares issued—15,070 shares fully paid, of which 70 are founders..	75,350	0	0			
3,537 shares on which £3 per share has been called up	10,611	0	0			
	85,961	0	0			
Less calls in arrear	1,475	0	0			
				84,486	0	0
Current accounts owing by the Company				5,195	8	11
The Electric Construction Corporation, Limited, on account of stock				13,046	17	7
Profit and loss account—balance				5,763	11	9
				£108,491	18	3

Assets.	£	s.	d.	£	s.	d.
Patents, etc., at cost				75,160	0	0
New plant, tools, furniture, fixtures, and fittings......................	903	11	9			
Less 5 per cent. depreciation ..	45	0	0			
				858	11	9
Stock on hand				11,473	9	7
Current accounts due to the Company....				11,116	3	7
Cash at bankers..	9,786	19	3			
,, in hand	96	14	1			
				9,883	13	4
				£108,491	18	3

PROFIT AND LOSS ACCOUNT FROM JAN. 1, 1891, TO MAY 31, 1892.

Dr.	£	s.	d.
Rent, licenses, taxes, etc.................................. ..	6,016	8	2
General expenses, management, Directors' fees, etc.	11,231	11	3
Advertising, insurances, and travelling expenses...	2,141	0	1
Discount, interest, commission, etc.	5,296	4	11
Patent fees and charges and law expenses	2,579	19	8
Maintenance of buildings, plant, and tools, and depreciation written off.......	1,401	6	1
Balance of profit and loss account at Dec. 31, 1890	2,615	10	3
Balance of net profit carried to balance-sheet.........	5,763	11	9
	£37,045	12	2

Cr.	£	s.	d.
Balance from trading account.................	36,561	14	0
Rents receivable, etc..	483	18	2
	£37,045	12	2

NEW COMPANIES REGISTERED.

Holloway Electricity Supply Company, Limited.—Registered by W. Sharp, 13, Walbrook, E.C., with a capital of £2,000 in £10 shares. Object: to carry on the business of an electric lighting company in all its branches. There shall not be less than three nor more than seven Directors. Qualification, £500. Remuneration to be determined by the Company in general meeting.

Lithanode and General Electric Company, Limited.—Registered by Paine, Son, and Pollock, 14, St. Helens-place, E.C., with a capital of £100,000 in £1 shares. Object: to adopt and carry into effect an agreement expressed to be made between the Mining and General Electric Lamp Company, Limited, and its liquidator of the one part and the Company of the other part; generally, to carry on business as electricians, mechanical engineers, gas engineers, lamp manufacturers, manufacturing chemists, contractors for public and private works, etc. The first subscribers are:

	Shares.
J. E. Huxtable, 14, St. Helens place, E.C.	1
C. H. B. Ince, 102, Alexandra-road, South Hampstead	1
L. Mossop, B.A., 7, Cambalt-road, Putney	1
C. R. Pearson, 2, Balfour terrace, High-road, Leytonstone......	1
J. E. Wood, 10, Placquett-road, East Dulwich	1
A. C. Crane, 3, Wood-lane, Highgate, N................	1
J. H. Gedge, 14, Abbeyville-road South, Clapham Park	1

There shall not be less than three nor more than nine Directors; the first to be appointed by the signatories to the memorandum of association. Qualification, £500. Remuneration, £100 each per annum; Chairman £50 extra. In addition to the foregoing, 10 per cent. on the net profits after payment of 15 per cent. dividend.

Railway Electric Reading Lamp Company, Limited.—Registered by Jordan and Sons, 120, Chancery-lane, W.C., with a capital of £100,000 in £5 shares. Object: To purchase from the Railway Automatic Electric Light Syndicate, Limited, certain patents for the United Kingdom for electric reading lamps, granted to D. H. Davies and J. M. Tourtel; and, with a view thereto, to adopt and carry into effect an agreement expressed to be made between the Railway Automatic Electric Light Syndicate, Limited, of the first part, J. M. Tourtel and D. H. Davies of the second part, and this Company of the third part; also to enter into an agreement with the Metropolitan District Railway Company, by which the Company will be authorised to instal and work automatic electric reading lamps in their railway carriages. The first subscribers are:

	Shares.
B. H. van Tromp, 4, Hyde Park-terrace, W.	1
E. Garcke, 1, Great Winchester-street, E.C.	1
E. Etlinger, 27, Cavendish-road West, St. John's Wood	1
W. H. Fox, 9, Austinfriars, E.C.........	1
J. C. Bull, 1, Great Winchester-street, E.C.	1
J. M. Tourtel, 558, Mansion House-chambers, E.C.	1
F. C. Cocking, 192, Friern-road, Dulwich............................	1

There shall not be less than three nor more than seven Directors. The first are E. Etlinger, J. H. Kincaid, C. E. Spagnoletti, and B. H. van Tromp. Qalification, 50 shares. Remuneration, £800 per annum and 5 per cent. of the net profits after payment of 7 per cent. dividend.

Richmond (Surrey) Electric Light and Power Company, Limited.—Registered by Lumley and Lumley, 37, Conduit-street, Bond-street, W., with a capital of £50,000 in £5 shares. Object: to carry out the terms and provisions of the Richmond (Surrey) Electric Lighting Order, 1883, in so far as the same may be carried out in accordance with the provisions of an agreement, made December 8, 1891, between the Corporation of the borough of Richmond of the one part and Latimer Clark, Muirhead, and Co., Limited, of the other part, and, with a view thereto, to carry into effect an agreement expressed to be made between L. Clark of the one part and this Company of the other part, whereby the benefit of the said contract of December 8, 1891, is to be assigned to the Company. The first subscribers are:

	Sha es.
W. E. Grigsby, 7, King's Bench-walk, Temple	1
Sir E. Hertslet, C.B., Belle Vue House, Richmond, S.W.	1
D. B. Hall, Heywood, Maidenhead, Berkshire........................	1
R. L. Kidd, Kewfoot-road, Richmond, S.W.	1
J. Soares, Richmond, S.W.	1
F. B. Alston, K.C.M.G., 69, Eccleston-square.........................	1
E. C. Curtis, 15, Cranley-place, S.W................................ ..	1

There shall not be less than three nor more than 10 Directors; the first to be elected by the signatories to the memorandum of association. Qualification, £200. Remuneration, £600 per annum, divisible.

BUSINESS NOTES.

City and South London Railway.—The receipts for the week ending July 10 were £733, against £692 for the same period of last year, or an increase of £41 The total receipts to date from January 1, 1892, show an increase of £1,334, as compared with last year.

Companies of the Month.—The following electrical companies have been registered during the past month:

Electrical Clock Company, Limited, £1 shares	£1,200
Electrical Coal-Cutting Contract Corporation, Limited, £5 and £1 shares	402,000
Electric Lamp Company, Limited, £1 shares	4,000
Holloway Electricity Supply Company, Limited, £10 shares	2,000
London Electric Manufacturing Company, Limited, £1 shares	10,000
Pacific and European Telegraph Company, Limited, £10 shares	100,000

Chili Telephone Company.—The annual general meeting of the shareholders in this Company took place on Monday at Winchester House, Old Broad-street, Colonel R. R. Jackson in the chair. The Chairman, in moving the adoption of the report, stated that the falling off in the income of the Company in the past year was

really small when it was remembered that the system was monopolised by the State, and that its use by the public was suspended for eight months. The subscribers had been reconnected with the exchanges as quickly as possible, and there was every indication that the Company would share largely in the return of the national prosperity. The motion was seconded and adopted. A resolution was afterwards passed declaring a dividend of 10s a share, free of income tax, upon the ordinary shares, to be represented by certificates exchangeable on presentation before March 31, 1893, for an equal amount of the Company's fully paid shares.

Telegraph Construction and Maintenance Company. A half yearly general meeting of this Company was held on Tuesday, at 38, Old Broad street. Sir George Elliot, who presided, stated that during the past half year they had carried out a contract with the Western and Brazilian Company by laying about 770 miles of cable along the coast of Brazil between Santos and Chuy, and had made various repairs in that company's cables on the same coast. They had laid a cable nearly 300 miles in length along the eastern coast of Sumatra for the Dutch Government through the Eastern Extension Company; they had made several repairs in the German Government cable between Emden, on the River Emms, and Valentia, in Ireland; they had likewise made repairs in the Direct United States Company's cable on the banks of Nova Scotia. Their general business had been fairly good compared with a similar period of last year. On the motion of Mr Hewat, a vote of thanks to the Chairman and Directors closed the meeting.

Silvertown Company. A half yearly general meeting of the India Rubber, Gutta Percha and Telegraph Works Company, Limited, was held on the 7th inst. at the City Terminus Hotel, Mr S. William Silver presiding. The Chairman stated that the general sales of the Company were increasing. The additional capital referred to at the last meeting was readily taken up, and the position of the Company had thus been much strengthened. They had manufactured and despatched the cable which was mentioned the last time they met; and their steamer "Silvertown" was now off the coast of Brazil engaged in laying the cables across the Atlantic to the West Coast of Africa. Their works, buildings, and machinery were in excellent order, and they were in a position to meet any demand which might be made on them. He concluded by proposing the payment of an interim dividend of 5 per cent., or 10s per share, tax free. Mr. Matthew Gray (the managing director) seconded the motion, which was unanimously carried.

Telephone Amalgamation in the West of England. A special meeting of the Western Counties and South Wales Telephone Company was held last Friday at Bristol to confirm the amalgamation of the Company with the National Telephone Company. Mr George White, on behalf of dissenting shareholders, protested against the arrangement, saying the terms were unfair. He had taken counsel's opinion, and it was very strong indeed with regard to the ability of dissentient shareholders to upset the agreement with the National Company, but if he went to the Court to upset the sale and was successful he should find himself driven back into the hands of the liquidator, who would deal with the property as he might choose. If he could upset the sale without landing the shareholders in this difficulty he would have done it at his own expense. The Chairman replied that what the Directors proposed was in the interests of the shareholders, and although the terms offered were not all they could wish, they were the best obtainable. The meeting confirmed the agreement.

Edison and Swan United Electric Light Company. The ninth annual report of this Company says that the business of the Company has resulted in a credit balance of £74,810. 16s. 7d. Of this amount £30,271 15s. 11d. has been already distributed as an interim payment on the A shares for the first six months of the year in respect to dividend and arrears. The Directors recommend a further distribution of a dividend on the A shares of the Company of 5s. 8¾d. per share on the 89,261 ordinary shares, £3 paid, of 9s. 6½d. per share on the 5,000 £5 fully paid shares allotted to the Edison Electric Light Company, Limited, and of 8s. 10¾d. per share on the 12,139 £5 fully paid shares allotted to the Swan United Electric Light Company, Limited, free of income tax, being, with the interim dividend paid on the 22nd February, 1892, 7 per cent., in respect of the year ending 30th June, 1892; 7 per cent. in payment of arrears of cumulative preferential dividend for the year ending 30th June, 1887, and of 4 per cent. in respect of the year ending 30th June, 1888; all to be distributed in accordance with the provisions of clause 87 of the articles of association, which will absorb £33,354 4s. 9d., leaving £11,184 15s. 11d., which the Directors have carried to the reserve fund, in accordance with clause 89 of the articles of association.

PROVISIONAL PATENTS, 1892.

JULY 4.

12350. **Working by electricity weaving and spinning machinery.** Frederick Francis Bennett and Henry Curwen, 8, Bank parade, Preston.

12381. **Improvements in the manufacture of plates for storage batteries or accumulators and the accessories thereto.** Edward Bradford Bright and Mark Bailey, Archway House, Esher, Surrey.

12392. **Improvements in the manufacture of wire stripe and the like by electro deposition.** Richard David Sanders, 4, South street, Finsbury, London.

12396. **Improvements in the lighting of railway trains electrically.** Illius Augustus Timmis, 2, Great George street, Westminster, London.

JULY 5.

12397. **An improved method of regulation of the potential difference of electrical conductors more particularly with regard to the variation caused by the varying current in the middle or "third" wire of a three-wire system.** Josiah Sayers, 49, Melbourne street, Derby.

12417. **Electric brazing and soldering devices.** Willis Mitchell, 30, Southampton buildings, Chancery lane, London. (Complete specification.)

12436. **Improvements in electric insulators.** Henry Harris Lake, 45, Southampton buildings, London. (Louis McCarthy, United States.) (Complete specification.)

12442. **Improvements relating to the lighting and heating of railway and other vehicles by electricity.** Leon Denso Adler, Joseph Loewenberg, Samuel Young, and Morris Moskowitz, 45, Southampton buildings, Chancery lane, London. (Complete specification.)

JULY 6.

12468. **Improvements in electricity meters.** Joseph Edmondson and Joseph Oulton, Penny Bank Chambers, Waterhouse street, Halifax.

12474. **The safety arc lamp.** Robert Drysdale, 141, Upper Mary street, Balsall Heath, Birmingham.

12506. **A new improved telephone transmitter.** Rowland Hughes Jones, Norfolk House, Norfolk street, Strand.

12511. **Improvements in electromagnetic clutches.** Edith Willans, widow and administratrix of the late Peter William Willans, 24, Southampton-buildings, Chancery lane, London.

JULY 7.

12528. **Improvements in telephonic apparatus and switches.** George Lee Anders and Walther Kottgen, 10, Jeffrey's square, St. Mary axe, London.

JULY 8.

12618. **An improved combination wall socket and switch for electric currents.** Louis Schramm and Samuel Thomas Wyand, 9, Warwick court, Gray's inn, London.

12619. **An improved electric switch.** Louis Schramm and Samuel Thomas Wyand, 9, Warwick court, Gray's Inn, London.

JULY 9.

12655. **Improvements in conduits for electric or cable roads.** Percy Willis, Victoria chambers, Chancery lane, London. (Carence Harding Bates, William Alder Miller, and William Ragan, United States.)

SPECIFICATIONS PUBLISHED.

1891.

9915. **Electrical distribution.** Swinburne and Holt.
11886. **Electric arc lamps.** Cance and others.
12009. **Electric motors.** Maquay.
13114. **Electric furnaces.** Parker.
13387. **Dynamo electric generators.** Caxal.
13628. **Electric dynamos.** Hartnell.
13928. **Electric locomotives.** Atkinson and others.
14171. **Electric cars.** Grimston.
14850. **Incandescent electric lamps.** Cunningham.
14987. **Electrical drill.** Siemens Bros. and Co., Ltd., and others.
15240. **Dynamo electric machines.** Siemens Bros. and Co., Limited, and Hind.

1892.

3881. **Electrical accumulators.** Kahabka.
7172. **Electrical surgical instruments.** Bradley.
8463. **Electric arc lamps.** Cooper.
9136. **Electric alarms.** Thorn.
9282. **Telephonic installations.** Abel. (Societe Generale des Telephones.)
9470. **Electric pushes.** Lake. (Jones.)

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3
— Pref.	—	[illegible]
India Rubber, Gutta Percha & Telegraph Co	10	[illegible]
House to House	5	[illegible]
Metropolitan Electric Supply	—	[illegible]
London Electric Supply	5	[illegible]
Swan United	3¾	[illegible]
St. James'	—	[illegible]
National Telephone	5	[illegible]
Electric Construction	10	[illegible]
Westminster Electric	—	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]

the Irish capital will be again with light before the leaves fall.

Grimsby.—The question of lighting the Central Market by electricity is to be left over until the matter of lighting the Town Hall is completed, the Corporation (as will be seen in another column) not taking over this installation till it is in a perfect and finished condition.

Bray.—The work on the establishment of the Bray central station is now practically complete, but the date for formal inauguration is not yet definitely fixed. Several test runs are being made, and as soon as the necessary adjustments are made the permanent lighting will be undertaken.

Holborn.—The County of London (North) Electric Lighting Company, and the Islington and General Electric Supply Company have forwarded notices to the Holborn Board of Works intimating their intention of applying for provisional orders to supply electric light to the Holborn district.

Cornwall Exhibition.—Intending exhibitors, especially those interested in mining plant, should not forget the Royal Cornwall Exhibition to be held, on August 23rd, at Falmouth (see last volume, p. 533). Mr. R. B. Rogers, 10, Gerald-road, S.W., agent; Mr. Edward Kitto, Falmouth, secretary.

Colombo Tramways.—Messrs. Hutchinson and Co., of London, who have undertaken the construction of the Madras electric tramways, have applied for a concession for 21 years for a similar line in Colombo, Ceylon, but for an overhead conductor system, and for goods as well as passengers.

Surveyors' Institution.—It has been decided to light the Surveyors' Institution with electric light. The work is being carried out, under the superintendence of Mr. Morgan Williams, of the firm of Messrs. Morgan Williams and King, consulting engineers, by Messrs. Pyke and Harris, of Westminster.

Natural Currents.—A curious effect of the abnormal weather is reported from the Bengal-Nagpur telegraph system. It was found that the natural current of electricity prevailing was much greater than the artificial; so much so, that measuring the one numerically by 4 the other was represented by 9.

Southampton.—A Local Government enquiry has been held in respect to the application of the Council to borrow the sum of £660 for electric lighting at Otterbourne. The contract for the erection of the necessary plant for electric lighting at the new baths has had the Corporation's seal affixed.

Telephonic Communication with Paris.—On Monday, at 10 a.m., a call office was opened in connection with the London-Paris telephone at the West Strand Telegraph Office, Charing Cross. The office will be open day and night. The charge for telephonic communication with Paris is 8s. for a conversation of three minutes.

The National Telephone Company have recently appointed Mr. A. Calder, their London manager, in succession to Mr. Dane Sinclair, now engineer-in-chief. The appointment, while being a popular one, will tend to bring with it increased prosperity to the company, as Mr. Calder has been long in the service, and has had a most varied experience.

Poplar.—On the receipt of a letter from the County of London Electric Lighting Company to the Poplar District Board stating that they proposed to apply for a provisional order to supply Poplar with the electric light, it was resolved that the Works Committee should consider the desirability of the Board applying itself for a provisional order.

Camberwell.—The Board of Trade have written to the Camberwell Vestry, stating that the Islington and Camberwell Electric Lighting Company had failed to satisfy the Board that they were in a position to discharge the duties and obligations imposed upon them, and were in favour of a revocation of the order. The Vestry has agreed to this course.

Cannes.—The British Vice-Consul at Cannes says that lighting by electricity has been partially adopted by a certain number of hotels and villas, and also by some of the principal tradespeople. It is generally considered to be satisfactory, but as yet no attempt has been made at lighting the town; in fact, this cannot be done before the contract between the town and the gas company has expired.

Alternating-Current Motors.—The Bernstein Electric Company, of Boston, has introduced a neat little alternating-current motor for fans and other domestic purposes. The motor has no electrical connection between armature and field; it runs with one brush and without sparking. It is noiseless, self-oiling, and takes 65 watts on either 50 or 100-volt circuits. The motor is of $\frac{1}{4}$th h.p. and drives a 12in. fan at 1,600 revolutions.

Appointments.—The third mathematical mastership at Merchant Venturers' School, Bristol, is vacant—£120 a year and share of fees. Application to G. H. Pope, Merchants' Hall, Bristol, by 22nd. Teachers in mathematics, magnetism and electricity, elementary physics, Spanish and lecturer on experimental general science, are wanted for the Bootle Technical School. The Staffordshire Educational Committee require a lecturer on mining; salary £250.

Prices at Chicago.—The following is the statement sent out to consular officers by the Director-General with reference to pricing of exhibits at Chicago: "Foreign exhibitors in the World's Columbian Exposition will be permitted to state upon placards attached to their exhibits the price at which said products will be sold at the place of manufacture, and also the prices in bond and out of bond, or exclusive and inclusive of the customs duties in Chicago.

Progress of Electric Light in London.—We notice the following installations are being put in by Messrs. Drake and Gorham, pointing to the fact that the necessity of paying a fair price for good work is being recognised by many of the leading offices: The London Assurance Corporation, Royal Exchange (with 180 lights), the Law Union Fire Offices, Chancery-lane, the Credit Lyonnais, Charing Cross, and the Bank of Egypt, Old Broad-street.

City Lighting Company.—Mr. G. H. Nisbett and Mr. F. H. Jackson have been appointed respectively second and third engineer to the company. Mr. Nisbett was formerly with Messrs Paterson and Cooper, and Mr Jackson was out-door superintendent to Messrs. Willans and Robinson, and until recently they were both members of the staff of Major-General Webber, late chief engineer to this company, the former being chief assistant and the latter station engineer.

Wigan.—The Town Council of Wigan are determined to take the bull by the horns, and introduce the electric light at a stroke. Convinced by a visit to Bradford of the possibility of the success of the light at a charge of 6d or even 5d. a unit, they have decided to issue circulars asking, as at Bradford, for customers who will bind themselves for three years, and to undertake the supply as soon as possible. Their provisional order expires in August, unless the work is commenced.

report will be submitted as to the probable cost and most convenient areas to be lighted.

Communication to Lightships.—The Royal Commission on electrical communication between lightships and lighthouses and the shore, held on Tuesday its first regular meeting in Northumberland-avenue, London, the Earl of Mount Edgcumbe presiding. Sir George Nares, Sir Leopold M'Clintock, Mr. F. Bedwell (hydrographer to the Telegraph Construction and Maintenance Company), and Mr. Scott (secretary to the Meteorological Council) gave evidence at considerable length. The Commission examined models showing the swivel mode of attachment to the "Sunk" lightship, and inspected charts showing the number of casualties and of lives lost at various points on the coast of the United Kingdom. A second meeting was held on Wednesday, special attention being given to those lighthouses which have not at present any proper means of communicating news of a wreck or of a vessel in distress.

Yarmouth.—The electric lighting question is becoming a pressing one in Yarmouth, but the Corporation is desirous of not proceeding too fast. The Electric Lighting Committee reported at last Town Council meeting that they had issued conditions and instructions for an installation, the tenders being required by July 28th. They further reported that a tender, with specification, had been received from Messrs. Crossley Bros., offering to fix a dynamo and apparatus for running an electric light installation from the engine now employed for pumping sea-water, and providing 20 50-c.p. lamps on the Marine Parade for a sum of £250 a year. The committee have not accepted the offer, preferring to wait for the advice of Mr. Preece, with whom they have opened negotiations, with the view of securing his services in helping to settle upon the best scheme for lighting after the tenders have been opened. The committee's report was adopted without discussion.

St. Helens.—The St. Helens Town Hall was on Monday lighted up electrically for the first time. There are a total of 338 16-c.p. lamps, of which the assembly-room has three 40-light gasoliers adapted to electroliers. The Council-chamber has 10 three-light polished brass pendants, and in the reading room the coolness is much appreciated. The cost of the new fixtures has been £1,500, and it is calculated that the expense of working it will only be about two-thirds that of gas. The electrical plant for generating the electricity has been supplied by Messrs. Bumstead and Chandler, Hednesford. The wiring was carried out by Messrs. J. D. F. Andrews and Co., under their resident engineer, Mr. J. D. Bailey, and has been superintended for the consulting engineer, Mr. W. Holmes, M.I.C.E., by Mr. C. H. Yeaman, engineer to the Prescot Electric Lighting Company. The specifications were prepared by the borough engineer.

Electricity for Railways.—Amongst the talk for and against the prospects of electric traction for long railways, the following explicit reply to an interviewer from Mr. G. Westinghouse, jun., is distinctly interesting: "As to the operation of standard-gauge roads by electricity in place of the present steam locomotive, such talk is all moonshine. It is a question of centralising the power economically. Now, the present locomotives have nearly the full efficiency of a stationary steam engine and boiler. To put in its place an electric motor connected by structure with a steam plant corresponding to an aggregate of all your steam-boiler plants on wheels would be really duplicating your power equipment with but little advantage and no economies, while there is a reduced efficiency by reason of the transmutation of the heat units from the coal through dynamos and wires to an electric motor on wheels. In the present stage of electrical science, talk of the operation of standard-gauge roads throughout the country by electric traction is wholly visionary."

Douglas.—By the enterprise of the Douglas Grand Hotel, Theatre, and Baths Company, formed last year for the purchase of an extensive block of buildings fronting the Promenade at Douglas, a very effective system of electric lighting of the hotel and baths has been inaugurated. The plant and installation have been supplied by the Brush Company. The principal rooms of The Grand Hotel have been fitted up with incandescent lights; the baths adjoining are supplied with both incandescent and arc lights, while the outside of the building is illuminated with arc lamps. The largest of the two sea water swimming-baths has been altered and rearranged, so as to be available for entertainments; and seats are provided for about 1,000 spectators. During the season daily performances will be given of an amusing nature; while the exhibitions of feats of skill and endurance will also be a feature. The great advantages of the electric light will be here much appreciated, for, while the interior of the building is lighted by arc lamps, there is also an arrangement of incandescent lamps underneath the water to enable the spectators to clearly observe all the actors when they are in the water.

Leamington.—Matters electrical do not seem able to go smoothly in this delightful watering place. There is one thing, however, the Leamingtonians—at least, the hotel portion of them—know how to do, and that is in busy times multiply ordinary charges by three, as they did during the Agricultural Show. But that is not electrical. At the last meeting of the Council, the Midland Electric Light and Power Company, Limited, wrote stating that on Saturday, June 14, they discovered that one of the Corporation water-pipes, which was in a bad and neglected condition, had rusted through and was leaking into the trench containing the electric light cables. This had evidently been going on for some weeks, as all the cables, nine in number, in that part of the trench were considerably damaged, and one of the most important ones corroded right through. The severing of this latter had caused considerable inconvenience and expense in remedying the defect in the supply of electric current. The Council were not very much impressed with this letter, one councillor stating that the company had only themselves to blame in the matter, though why this should be so was not clear.

Heckmondwike.—At the last meeting of the Heckmondwike Local Board the Electric Lighting Committee recommended the Board to take the necessary steps for constructing electric arc lighting plant. The committee visit Loughborough, not at the Board's expense, to inspect the system of electric lighting there. The scheme has been prepared under the direction of Mr. Hutchinson, C.E., embodying overhead system with both arc and incandescent lights. The scheme stipulates for three sets of compound engines and dynamos, of which two sets only are required for an output of 1,000 lights, one set being kept in reserve, and two boilers are provided. The output will be equal to 1,500 16-c.p. lights, and as more lights are added, in similar proportion will the cost of the plant and the annual working expenses be reduced. The light in the Market-place would be ten times as effective as at present at about the same cost. The committee are hopeful as to a demand for the light by shopkeepers and others. The estimate of the cost shows the initial outlay to reach about £4,450, whilst interest, depreciation, and maintenance are put down at £1,048 per year. The estimated annual revenue is £1,432.

Fire Alarm Telephones.—In an interesting note published some time at the beginning of the year the chief of

the Metropolitan Fire Brigade notified to the citizens of London that care should be taken not to trouble the brigade with false alarms. We were told that quite a large proportion of the fire alarms received by the brigade were false alarms—mischievous and otherwise. This constitutes a serious difficulty in the way of the action of the brigades, as it not only involves turn-outs and loss of time and temper, but it may well happen that a true alarm may follow and the engines are away on a bootless errand. The application of the telephone to fire alarm posts promises to obviate this defect in the system. Paris has already adopted the telephonic alarms for the "Sapeur-Pompiers." Instead of breaking a glass and pulling a handle merely (and sometimes running away), the person who advises a fire breaks a seal, opens the door and shouts in the opening of the telephone receiver "Fire, Smith-street, No. 20," or other detail, until a fanfare of trumpet or bell advises him the engines have started. In *Les Inventions Modernes* for July 20 (4, rue Chaussée-Antin, Paris), the whole arrangement is described and very fully illustrated. The apparatus is supplied by the Société Générale des Téléphones, 41, rue Caumartin, Paris. It seems that private persons can have the telephone alarms fixed on their own premises at a moderate cost.

Mine Surveying. — Some interesting and amusing information is given in the Cantor lectures by Bennett H. Brough, published in the *Journal* of the Society of Arts, of the use of the magnetic needle in mine surveying. The needle, says Mr. Brough, has been largely used in Sweden and in the United States. The theory of its use is based on the fact that certain ores become magnetic by induction under the influence of the earth's magnetism. By noting the dip of the magnetic needle the extent of the iron deposit can be ascertained. Prof. Le Neve Foster mentions the case of an iron deposit in Sweden being mapped out by observations on the ice. Compass explorations being in many instances a source of income, a skilful operator often wishes to keep his mode of procedure a secret, and the supposed supernatural properties of the divining-rod are transferred to the compass. Unfortunately, the compass is admirably adapted for dishonest purposes. The case is recorded of an American prospector whose compass needle, in the vicinity of an ore mass, always showed a dip of 90deg. when facing west, and the true dip due to local attraction when facing east. The former position was successfully used in selling and the latter in buying the iron ore ground. In Sweden a magnet in the walking-stick has been successfully employed to give a large dip when it was thought advisable to mislead the purchaser. Of late years, purely scientific methods of exploring for iron ore with the magnetic needle have been introduced, and in this way important deposits have been discovered in Sweden; whilst in New Jersey, in six years, the annual production has increased 50 per cent. by the addition of new producing localities found by the compass.

Garden Party.—Lauriston, Mr. J. W. Swan's residence in the pretty town of Bromley, Kent, was the scene of a brilliant assembly at Mrs. Swan's garden party on Thursday last week. Visitors are always favoured with a singularly happy combination of musical and artistic charm with scientific novelty, and the present was no exception. Max Hambourg, the Russian musical boy prodigy of 13, discoursed deftly and masterfully the music of Liszt, and other difficult composers, under the admiring gaze of Mrs. Swan's friends, amongst whom were Dr. and Mrs. S. P. Thompson, Dr. Dallinger (the eminent entomologist and divine, and his wife), Prof. Elisha Gray, with Mr. W. J. Johnston, from America, Mr. Percy Bigland (the painter of Mr. Gladstone's portrait) and his wife—late Miss Aggs—a noted lady traveller; together with many electrical and other celebrities. Miss Dora Tulloch gave some admirable recitations, and a marvellous silhouettist was only prevented from exhibiting his skill by sudden illness. In Mr. Swan's laboratory the scientifically inclined saw the process of electro-deposition of copper, recently described before the Royal Institution, in actual work. Large slabs were being deposited in a rocking bath of special solution, driven by an electric motor, and specimen anodes and cathodes were shown. A thin strip of perfectly coherent and brilliant copper was deposited before visitors' eyes in two minutes only. But the most interesting, perhaps, was the wire deposition. A long trough of solution contained a wire, which was being drawn backwards and forwards through sapphire dies. Deposition occurred, but as the diameter of the wire was always kept the same by the dies, the length, of course, grew, and a wire of any length might thus be obtained by direct deposition. It was curious to examine the cross-section of such a wire under the microscope, when the original core had nearly disappeared under successive layers. The quickness of the deposition (fifty or a hundred times that of ordinary processes) is, of course, the great advantage of Mr. Swan's process, the exhibition of which created a great deal of interest.

Amsterdam.—As early as 1888 a small installation of 231 kilowatts, supplying 2,000 16-c.p. lamps, was established in Amsterdam. Of this, 156 kilowatts was continuous current at 65 volts, distributed on overhead wires; and 75 kilowatts in alternating 2,000-volt current, distributed in underground concentric mains of a total length of about two miles. In 1890 the Electra Society, who owned this installation, obtained a 28 years' concession for lighting the town. To comply with the conditions determined upon, a new station was opened on the 28th of May last for alternating-current system alone. The station is situated about a mile from the town, and contains eight multitubular MacNicol boilers, each of 153 square metres heating surface. Three horizontal steam engines of 700 h.p. are used, of the type shown at Frankfort by the Helios Company, of Cologne, each driving a Ganz alternating dynamo, giving at 195 revolutions 400 kilowatts at 2,000 volts, at a frequency of 50 periods per second; also an exciter of 20 kilowatts of 65 to 100 volts. A fourth set, same type, of 200 h.p. produces 150 kilowatts; and a fifth consists of a vertical Dingler engine of 160 h.p., developing 75 kilowatts. This latter is the engine that used to drive the old station, which is being given up. The total power is 2,260 h.p., or 1,500 kilowatts. All are condensing engines. The current is distributed by Felten and Guilleaume concentric lead-covered cables, armoured and served with an outing coating of hemp. The cable is laid in wood troughs, filled in with asphalte and covered in with brick. Cast-iron boxes are used for distribution; a length of 20 kilometres, or 32 miles, has already been laid. The transformers are of closed-circuit type, by Ganz and Co., transforming from 2,000 down to 72 or 36 volts. The 72-volt circuit is used for arc lamps, which are run two in series on this voltage. The current is supplied at 46 cents per kilowatt-hour—say 9½d. a unit. Consumers taking a supply of over 750 hours a year have a 30 per cent. reduction. Frager and Ganz meters are both used, and each installation pays a certain annual charge besides for service, according to its size. There are 6,100 lamps of 16 c.p. at present being supplied. These particulars are taken from the *Bulletin Internationale de l'Electricité*, a journal always full of crisp and useful information of electrical matters on the Continent.

ANNUAL MEETING OF MUNICIPAL AND COUNTY ENGINEERS.

The annual meeting of this society commenced at Bury yesterday, and will be continued to-morrow. Mr. J. Cartwright, borough engineer of Bury, presided. There were one or two papers of interest to electrical engineers—that of Mr. Cox, relating to tramways, and that of Dr. Burghardt, to sewage precipitation by electricity. We give Mr. Cox's paper in full, and such portions of Dr Burghardt's as relate to electricity. Besides papers, a number of visits were arranged, those to the mills of Messrs. Musgrave and Co., and to the works of Messrs. Mather and Platt being of interest to our readers—the former because of the mills being electrically lighted, the latter because the firm is one engaged in manufacturing electrical apparatus.

Street Tramways and Electric Traction.

BY J. H. COX, M.I.C.E.

The first tramway in England was laid by Mr. G. F. Train in 1860, at Birkenhead, by permission of the Birkenhead Commissioners, but it was not viewed with much favour by the public, and therefore it was not until 1868 that an Act of Parliament was obtained authorising the construction at Liverpool of the first English system of street tramways for passenger traffic. Since that date they have spread very rapidly all over the country, until the total length has reached over 1,000 miles, representing an invested capital of more than 14 millions.

Many different systems of tram rails have been adopted, the earlier lines being laid with light wrought-iron rails on longitudinal or transverse wood sleepers. The cars at first were all drawn by horses, but as steam engines became introduced about 1876, engineers were compelled to construct the permanent way in a more substantial manner. Wood sleepers were discarded for metallic ways, and iron rails were superseded by steel. Steam engines have done good service on tramways, especially in those towns where the gradients are too steep to be worked by horse power, but they are very destructive to the permanent way and are not entirely free from other objections, such as noise, smoke, steam, dust, and smell. It should not be forgotten that steam engines have not only to haul the heavy cars and passengers up these hills, but they have their own ponderous weight to drag up likewise, and on the downward journey the everlasting jerks when the brake is applied are a source of damage both to the engines and the permanent way.

It may be interesting to some of you to have the figures showing the cost of maintenance for the Manchester-road tramway in Bradford, which has been worked by steam power for the last seven years. The rails are of steel, 7in. deep, girder pattern, weighing 103lb. to the yard, laid on concrete foundation, and the road is paved with granite setts from kerb to kerb. The line is 2 miles 16 yards in length, 1 mile 789 yards being double line, and 987 yards single line. Line opened September 5, 1884.

					Per mile of single line.		
1884.*	Cost of maintenance,	rails,	and	paving	£2	12	4
1885	"	"	"	"	8	14	10
1886	"	"	"	"	17	3	8
1887	"	"	"	"	12	14	8
1888.	"	"	"	"	40	19	3
1889.	"	"	"	"	44	10	11
1890.	"	"	"	"	55	18	2

* Three months only.

The actual wear caused by a 10 minutes' service of cars on the tread of the rail up to the present time is $\frac{3}{16}$in. on the single line, and practically the same on the double portion. The engines are Green's, and weigh 12 tons. The bogie cars carry 68 passengers, and weigh eight tons when loaded with passengers.

The excessive cost of maintaining tramways worked by steam has caused many tramway authorities to look in the direction of cable haulage and electricity for deliverance from their troubles, and under suitable circumstances these modes of traction have already proved very successful. Those members of this association who attended the district meeting in Edinburgh in the autumn of 1890 saw a capital example of the cable system in operation in that city, and they were also favoured with a most interesting paper on the subject by Mr. Colam, the engineer. There is no need to repeat to an audience like this the many advantages which may reasonably be urged in favour of the cable system when applied to tram routes with severe gradients in populous districts which are able to support a very rapid service of cars; but there are very few tram routes, except in the largest towns, which can maintain a five minutes service, which is necessary to make cable haulage a complete success. The Bradford Corporation were reluctantly compelled to drop the idea of introducing this system into Bradford for the projected tramway in the Wakefield road district, mainly because of the difficulty of keeping up a rapid service of cars, and enquiries were therefore started as to the cost and capabilities of electricy as a motive power for working tramways on steep gradients.

Electric traction, as you know, has made wonderful strides since Dr. Siemens laid the first electric tramway at Berlin. Only one decade has passed since then, and now upwards of 3,000 miles of lines are worked by electricity in America alone. Our American cousins appear to live and move at a high-pressure rate, and do not stick at forming a network of wires over their streets, so long as it facilitates locomotion; but in Europe we proceed more cautiously, and there is little doubt that these objectionable overhead wires have considerably interfered with the progress of electric traction on this side of the Atlantic. With electricity as a motive power, we have the choice of the proverbial three courses: First, to work by means of storage batteries placed under the car seats, as at Birmingham; secondly, by the underground system; and, thirdly, by overhead conductors.

As to the first, or storage system, we have a splendid example at Birmingham, which, by the courtesy of the chief engineer, Mr. Dickinson, I had the pleasure of inspecting some 18 months ago, soon after its opening. To my mind it is an ideal system, and I sincerely hope it may some day supersede both the underground and overhead methods, but, unfortunately, there is at present little hope of such a consummation—at any rate, on gradients such as exist in Bradford. On level routes it is a system even now well worthy of consideration, and although it may be more costly to work than the overhead and conduit systems, yet it has many advantages over its rivals, such as the cars being able to run quite independently of each other, and independently of either overhead or underground wires, thus freeing the streets of many objectionable obstructions. It has many other advantages that I need scarcely recount to a meeting like this—not the least of which is its freedom from one serious drawback of the direct system—viz., where a breakdown of the principal machinery at the power station causes a temporary stoppage of the entire system.

Unfortunately, there are some disadvantages, the two most serious being the great weight of the batteries, which, at Birmingham, on a comparatively level line, amounts to 4,800lb., or 2 tons and 3 cwt.; this, added to the weight of car and motor, making $8\frac{1}{2}$ tons for a car carrying 50 passengers. Another serious disadvantage is the deterioration of the batteries; and although some progress has been made within the last year or two in making the plates more durable and reducing the weight, there is still much room for improvement.

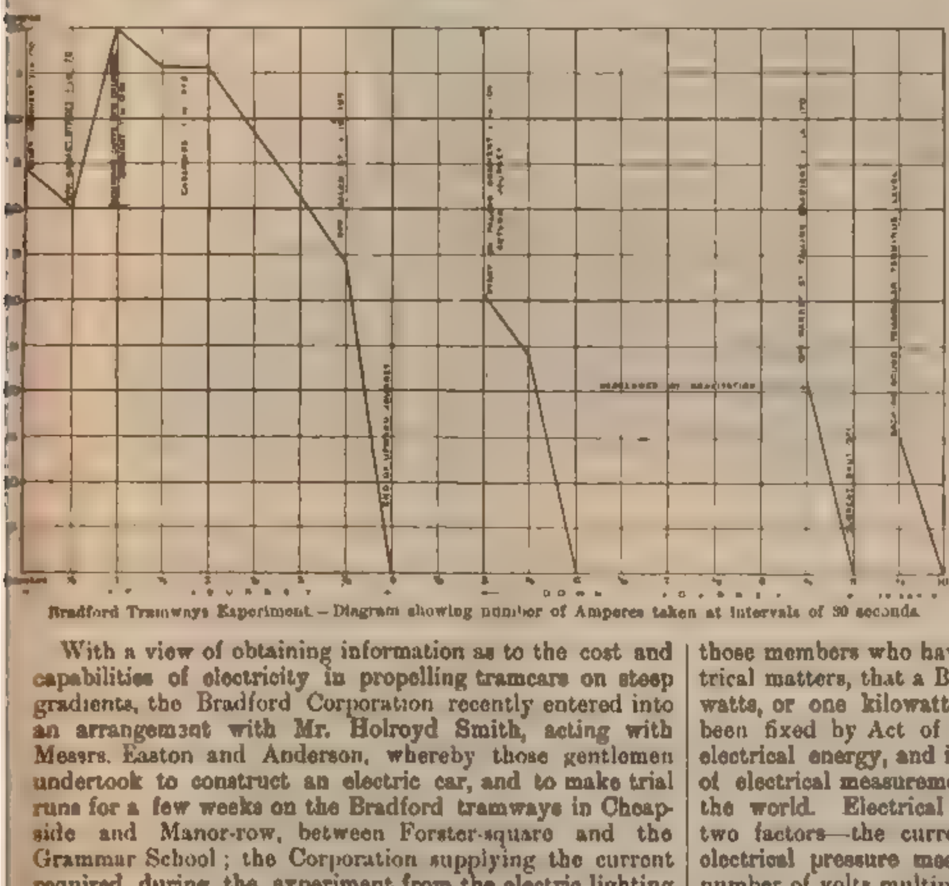
It is therefore necessary to turn to the direct system, where we have the choice of two methods—the underground or conduit system, or that of overhead wires. It is true there are several ingenious contrivances which may be included under the head of surface methods with electro-magnets attached to the car, but they have scarcely yet passed the experimental stage, and at present are certainly not practicable for hill climbing. The underground system, which has been for six years in operation at Blackpool, has proved fairly successful, in spite of the difficulty caused by the sand blowing into the conduit from the shore, and occasional flooding by sea water during storms, and by exceptionally high tides. In America this system has made very little progress, partly because of its extra cost, but mainly on account of the difficulty in preventing the conduit becoming filled with mud and water. This rather points to imperfect sewerage systems, and should not apply

to a well-drained town, where frequent connections would be made between the conduit and main sewer. An inland town would, of course, be free from sea-water and sand, and so long as the main sewers do not become overcharged during thunderstorms and heavy rains, I see no great reason why the conduit arrangement should not answer. Like the other systems, it is not free from disadvantages, but no doubt its large additional first cost and the drainage difficulty have been the chief factors in preventing its adoption to a greater extent in America.

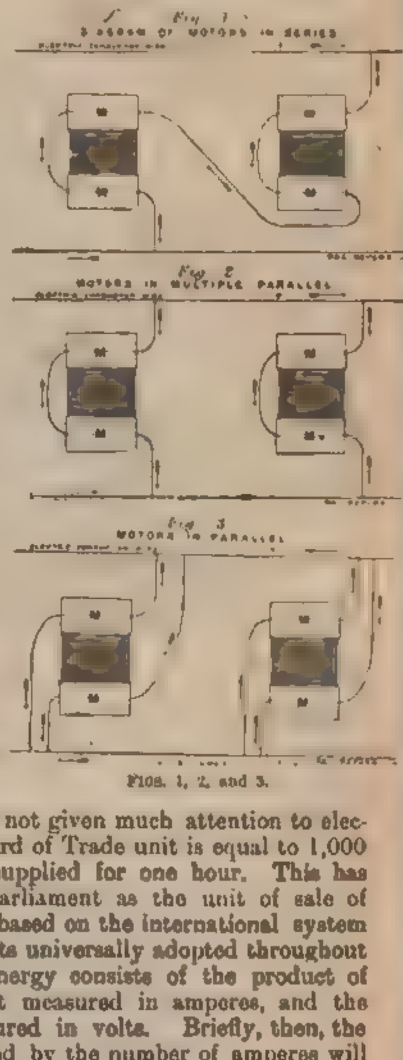
Finally, we come to the overhead system. On this side of the Atlantic there is no doubt a prejudice—or, to put it more mildly, a very strong objection, against allowing posts and wires to be erected in and over our streets; not only on account of disfigurement and obstruction, but also from fear of accident. On the latter score there is evidently little ground for misgiving, seeing that no fatal, or even serious, accident has occurred yet. As regards the disfigurement of the streets caused by the posts, no doubt it is possible to reduce the objection to some extent by using suitable ornamental iron posts; but as obstructions they will, I fear, be more apparent in our streets than in some continental cities, where they are to a great extent hidden by the long avenues of trees which line the edges of the footwalks. In many such cases the poles support lamps for lighting the road by electricity. Personally I should welcome either the conduit or overhead systems, if they would deliver us from steam haulage.

time per journey down, 3·73 minutes = six miles per hour; quickest journey up, when motors were worked in parallel, 2·00 minutes = 11 miles per hour; slowest journey up, 5·00 minutes = 4½ miles per hour. Total measurement of electricity used during the 13 days' run, 240 Board of Trade units. Average per mile run, 1·52 unit, say, 1½. Therefore, taking an average throughout the entire trial, the car required for its propulsion 2 e.h.p. hours per mile run. Cost per mile run for electricity, assuming the price to be 2½d. per Board of Trade unit, 3·81 pence. The price of 2½d. has been fixed by the Gas and Electricity Committee of the Bradford Corporation, and I am of opinion that they could afford to supply the current at 2d. per unit, a price which would not only pay for the generation of the electricity, but leave a sufficient margin to cover establishment and other charges. I may mention that only last week a private firm of engineers, having their works situate about half-way on the Wakefield-road route, offered to supply the current at 2d. per Board of Trade unit.

It may be as well to explain briefly, for the benefit of



Bradford Tramways Experiment.—Diagram showing number of Amperes taken at intervals of 30 seconds.



FIGS. 1, 2, and 3.

With a view of obtaining information as to the cost and capabilities of electricity in propelling tramcars on steep gradients, the Bradford Corporation recently entered into an arrangement with Mr. Holroyd Smith, acting with Messrs. Easton and Anderson, whereby those gentlemen undertook to construct an electric car, and to make trial runs for a few weeks on the Bradford tramways in Cheapside and Manor-row, between Forster-square and the Grammar School; the Corporation supplying the current required during the experiment from the electric lighting station, by means of overhead conductors, at a pressure of 300 volts. The length of the trial run is 660 yards, commencing with a tolerably level inclination of 1 in 340 for 100 yards, then curving into Cheapside on a gradient of 1 in 13·22 with a radius of 64ft. 6in., followed by a straight inclination of 1 in 14·75 for 193 yards, 1 in 20 for 137 yards, and terminating at the end of a comparatively level gradient of 1 in 104 for 160 yards. The total rise is 70½ft. or an average inclination of 1 in 28. The Wakefield-road route is even steeper than this, having a total rise of 352ft. from the Town Hall to Rooley-lane, a distance of 2,830 yards, or an average of 1 in 24. The experimental running began on the 16th of May and terminated on June 9. The car only ran on 13 days, and made 204 return journeys, or a total mileage, including the triangle at Forster-square, of 157½. Average time per journey up, 3·79 minutes = six miles per hour; average

those members who have not given much attention to electrical matters, that a Board of Trade unit is equal to 1,000 watts, or one kilowatt supplied for one hour. This has been fixed by Act of Parliament as the unit of sale of electrical energy, and is based on the international system of electrical measurements universally adopted throughout the world. Electrical energy consists of the product of two factors—the current measured in amperes, and the electrical pressure measured in volts. Briefly, then, the number of volts multiplied by the number of amperes will give the watts, and the watts divided by 746 will give the horse-power. A Board of Trade unit being equal to 1,000 watts supplied for one hour, is also equal to about 1⅓ h.p.

The number of passengers carried up was 1,321, or 6·4 persons per journey; passengers carried down, 912, or 4·5 persons per journey; greatest number of passengers carried up on one journey, 44; greatest number of passengers carried down on one journey, 38. The driver and conductor are not included in the above figures. The car has been stopped and started again on the steepest gradients without difficulty, even when fully loaded with passengers, and has taken the curve at the bottom of Cheapside without any preliminary rush. The E.M.F. has only varied very slightly, from about 280 to 300 volts. On several of the ascending journeys the voltmeter and ammeter carried in the car gave the following readings at various places on the route.

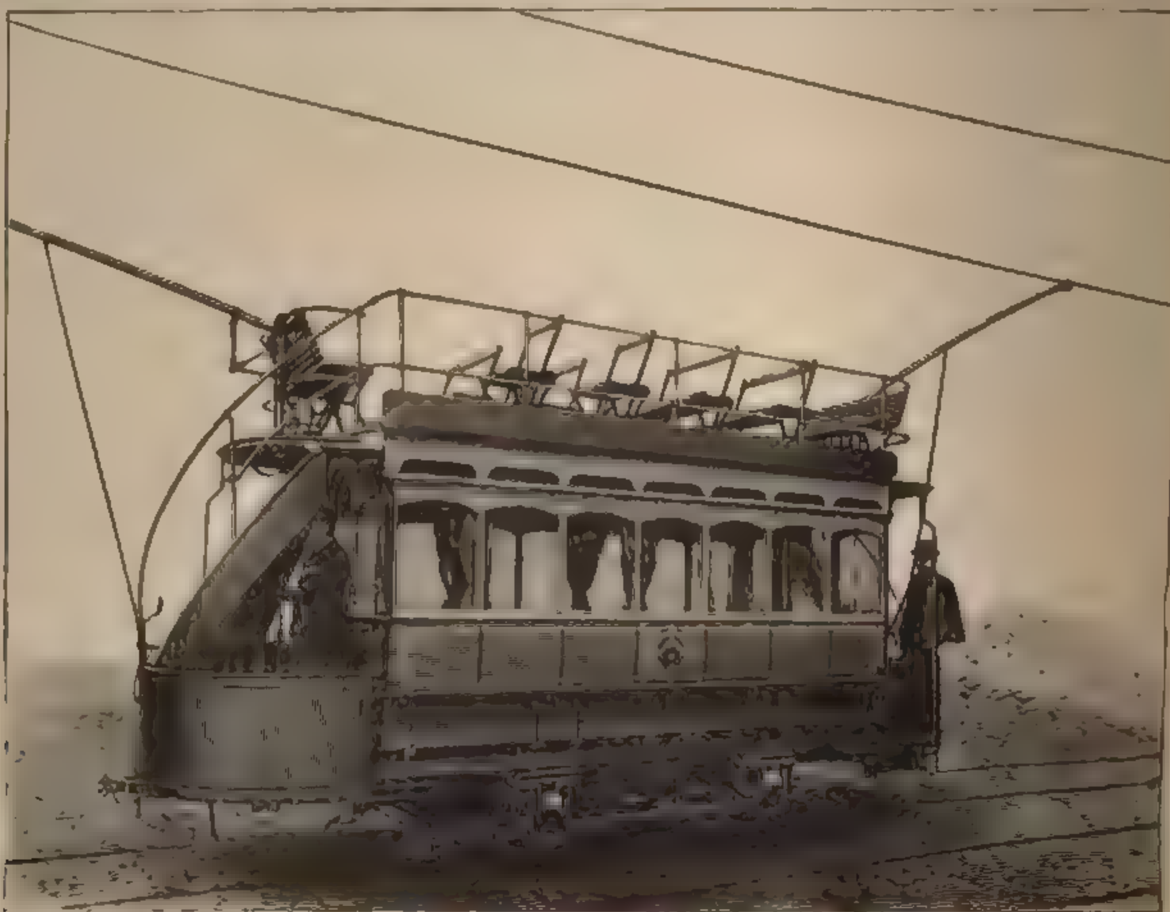
	Volts.	Amps.	E H P.	Gradient.
Opposite the end of Market street	294	40 =	15·76	1 in 170
Rounding curve into Cheapside	280	60 =	22·52	1 in 13·22
Half way up Cheapside	281	56 =	21·09	1 in 14·75
Opposite Salem street	281	34 =	12·80	1 in 85

On the descending journey :

Opposite Savings Bank	294	24 =	9·45	1 in 104
Rounding triangle, Forster-square	300	14	5·63	level

The momentary current required to start the car on the steep gradient in Cheapside was about 100 amperes. The dual armature motors may be set to work in series (see Fig. 1) which gives a slow speed of, say, four miles per hour; in multiple parallel, Fig. 2, which gives a moderate speed uphill of six to seven miles per hour; or in parallel, Fig. 3, a speed of 11 miles per hour.

During the trial some hitches occurred from various causes, occasioning delay; but nothing really serious happened to raise much doubt as to the ultimate success of the experiment. The motors at first produced a slight hissing sound, but this was soon remedied, and the running



Car built by Messrs. Easton and Anderson for the Bradford Electric Tramways.

car will seat 36 passengers, 18 in and 18 out, and weighs 3 tons 9cwt. 2qrs. The motor truck and motors weigh 3 tons 19cwt. 2qrs., total, say, 6½ tons; when fully loaded with passengers the total weight may be taken at 8½ tons. Dual armature motors of 15 h.p. each transmit motion to the wheels by means of worm gearing, and the of the motors and gearing afterwards was practically noiseless. An electric brake is available, so arranged that when the car is running downhill by gravitation alone it drives the motors, and they can be instantly set to act as dynamos generating a current that tends to drive them in a reverse direction, and so stops the car.

Motor Truck used on the Bradford Electric Tramways.

worm wheels are so attached that each car wheel is separately driven, each axle having only one wheel keyed upon it, the other being keyed upon a loose sleeve conjointly with a worm wheel. The electricity is controlled by three switches at each end of the car—one a main supply or emergency switch, one a regulating switch acting upon resistance coils, and one a setting switch whereby the two

Although a few mishaps occurred, as above stated, it has been clearly shown that the motors are amply powerful to work steep gradients. The car runs very smoothly, without making much noise or nuisance of any kind, and causes considerably less damage to the permanent way than the heavy steam engines and cars at present in use.

The net results, then, of the recent experiments is

electric traction at Bradford show that cars worked by electricity can be made to mount any gradient which can be climbed by a steam engine, and quite as cheaply, providing there is a tolerably quick service and plenty of traffic; that the energy required to ascend and descend such gradients, as I have mentioned, is 1½ Board of Trade unit per mile, and assuming the price of the electricity to be 2d. per unit, it follows that the cost of running up and down such gradients is 3d. per car mile.

As the primary object of the experiment was to ascertain the desirability or otherwise of adopting electricity for working the projected steep line in Wakefield-road, perhaps I may be permitted to state as briefly as possible the conclusions which I arrived at. The length of the proposed tramway route for Wakefield-road is 2¼ miles. The carriageway at present is not sufficiently wide to admit of the construction of a double line, and, if specially widened for the purpose, it would involve the narrowing of the footways to the extent of about 2ft. on each side of the road, at an expenditure of £1,600. A double line of ordinary tramway would cost £4,500 more than a single line with passing places, besides an additional cost of £3,150 for a double underground conduit.

There are also other advantages in favour of a single line—viz.: There is less interference with the roadway and ordinary traffic, less length of line to maintain, less rental for the lessees to pay, and experience has proved that the wear of a single line is very little, if any, more than that of a double line. This may appear somewhat strange, seeing that there is twice the amount of traffic passing over the single portions of the line that passes over the double portions; but the joints of a tramway are always the weakest places, and on a double line the heavy engines and cars are constantly travelling in one direction, which tends to beat or hammer down the leading end of each rail, thus causing serious damage both to the rail, fishplates, and concrete foundation at each joint, whereas on the single line the traffic passing in both directions compensates matters by pressing equally on both rail ends. Formerly there was some difficulty experienced in working a single line, and passing places with the electric and cable systems of traction, but such improvements have been made in the points and crossings that no serious difficulty need be apprehended in this respect. The estimates are based on a 15 minutes' service, which gives 80,000 car miles per annum.

WAKEFIELD-ROAD TRAMWAY.

Electric traction: Approximate estimate of working expenses, at per car mile, in pence.

Electrical energy	3·812	per car mile.
Wages of drivers and conductors	2·000	,,
Repairs to motors, etc.	1·000	,,
Repairs to cars	0·200	,,
Depreciation on rolling-stock	1·300	,,
Water and gas	0·250	,,
Rates and taxes	0·650	,,
Maintenance of electric conductor	0·345	,,
Compensation for damages	0·250	,,
Stationery	0·070	,,
Salaries	0·858	,,
For 80,000 car miles	10·735	

Owing to such a small car mileage as would be attained with the present limited passenger demand, the expenses work out exceedingly high, and it is quite hopeless to expect electric traction paying on a short isolated line like Wakefield-road, unless a much quicker service can be maintained with at least double the above number of car miles annually.

The working expenses, which I estimate at 10¾d. per car mile run, exclusive of rental,* would decrease rapidly in proportion to the number of miles run. For instance, for another line in Bradford—viz., Manchester-road tramway—having a yearly car mileage of 175,000, the rate for working expenses and rent would probably be reduced to 9d. Again, the receipts on this line are very high—viz., about 16d. per mile run—whereas on the Wakefield-road line they cannot safely be estimated to reach more than 11d. or 1s. per car mile. The following statement, marked A, gives a summary of the capital expenditure. Statement B shows the approximate annual working expenses.

*Conduit system, rental 3·31 pence per car mile additional—viz., 14d.
Overhead ,, ,, 2·46 ,, ,, ,, ,, 13¼d.

WAKEFIELD-ROAD TRAMWAY.—A.
Capital Expenditure.—Summary.

Description.	Permanent way.	Electrical work.	Widening carriage-way.	Main supply cable.	Total.	Equipment by lessees.
	£	£	£	£	£	£
Double line throughout, overhead conductor	16,200	3,190	1,611	750	21,751	8,900
Single line, overhead conductor	11,700	3,190	nil	750	15,640	8,900
Double line, conduit system	16,200	11,340	1,611	750	29,901	8,900
Single line, conduit system	11,700	8,590	nil	750	21,040	8,900
Steam traction, single line	11,700	nil	nil	nil	11,700	11,850

WAKEFIELD-ROAD TRAMWAY.—B.
Annual Working Expenses.—Summary.

Description.	Annual working expenses.	Annual rental.	Total.	Receipts.	Surplus.	Deficit.	Equipment by lessees.
	£	£	£	£	£	£	£
Electric overhead conductor	3,578	821	4,399	4,000	—	399	8,900
Electric conduit system	3,578	1,104	4,682	4,000	—	682	8,900

It is therefore certain that electric traction cannot be adopted for the Wakefield-road line so as to be self-supporting, the loss in case of an electric tramway with overhead conductor being £400 per annum, irrespective of the interest on the capital sum of £8,900 which would have to be spent by the lessees on the equipment of the line. This latter sum, taken at 5 per cent., would therefore make the total loss £845 per annum.

The loss upon an electric tramway with underground conductor would be still more, owing to the greater first cost of the line. The deficit in this case is estimated at £682, which, added to the interest at 5 per cent. on the sum of £8,900 for equipment, gives a total loss per annum of £1,127.

Seeing that two tramway companies already exist in the town, both employing steam as a motive power, the most economical course would undoubtedly be to let the line, if possible, to one of them, as the capital charges and working expenses would be considerably reduced in their case, than if leased to a new company or promoters.

The question I have therefore put to the Corporation is: Will they adopt steam traction for the Wakefield-road section for the unexpired portion of the lease which has now nearly 11 years to run; in the meantime gaining experience by observing the results of electric traction in other places? or, will they subsidise the tramway to the extent of the loss mentioned, and try electric traction for the remainder of the lease, and thus obtain reliable data, which may enable them to decide as to the motive power to be used on all the Corporation tramways when the existing leases have expired in 1903?

Sewage and its Purification.

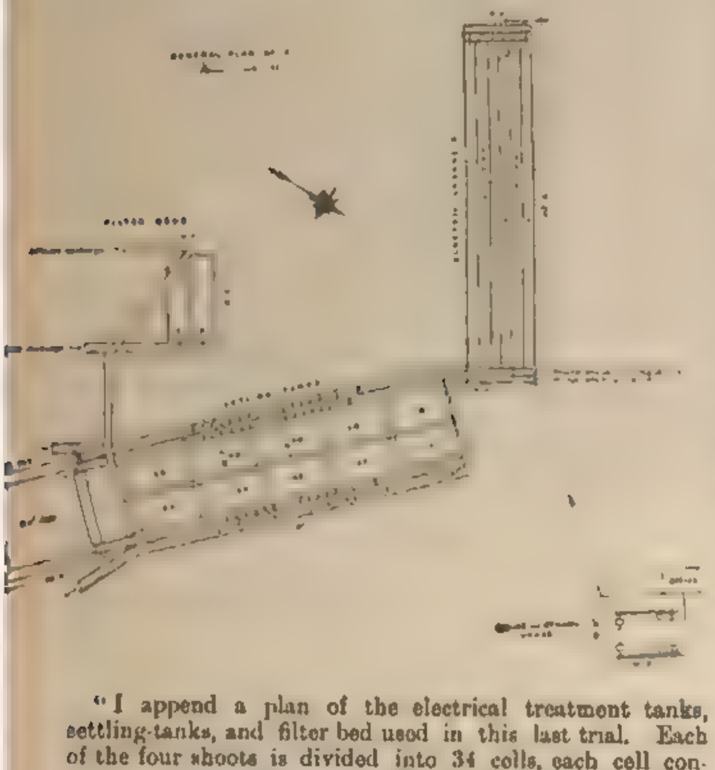
BY CHAS. A. BURGHARDT, PH.D., ETC.

(Abstract.)

We have recently called attention to what seems to be a wide field for the use of electricity, and to-day a paper by Dr. C. A. Burghardt has been read before the Municipal and County Engineers, the electrical portions of which we are able to give. After discussing various other processes, Dr. Burghardt goes on to say—

"The next process in which iron plays the part of purifier is the electrical purification process also described in the above-mentioned report. Briefly, the iron, which is the active agent, is derived from iron plates placed in cells through which the sewage constantly flows. The iron plates are so arranged that on passing an electric current through the series of cells one set are positive and the other negative. Only the positive plate is acted upon

and dissolved upon its surface, the hydrated ferrous oxide mentioned above being produced by the action of the nascent oxygen (liberated by the decomposition of the water at this pole) acting upon the metallic iron. This hydrated ferrous oxide (which is in solution) then acts upon the organic matter in the manner described above, becoming, firstly, hydrated ferric oxide by absorption of oxygen from the air, giving up this oxygen again to the organic matter and becoming the lower oxide, and repeating this operation for a considerable time until the carbonaceous matters which are oxidisable have been oxidised, when no further reduction of the ferric hydrate can take place and it remains insoluble and suspended in the effluent, as a yellowish precipitate. In order to cause the plates to wear off or dissolve equally, the poles are reversed on alternate days, a plate being positive one day and negative on another day. Since the issue of the Salford sewage treatment report in 1890, the electrical process has been submitted to a thorough trial, at Weaste, from October, 1891, to March, 1892, on a specified quantity of 4,167 gallons per hour, or 100,000 gallons per 24 hours. The current density employed was one ampere for every seven square feet of electrode surface, or 0·4 ampere-hour per gallon of treated sewage. The electric shoots or channels were constructed in four lengths—the smallest number which would be adopted in practice.



"I append a plan of the electrical treatment tanks, settling-tanks, and filter bed used in this last trial. Each of the four shoots is divided into 34 cells, each cell containing 16 iron plates each 2ft. by 1ft. 6in. by ½in. The total weight of iron plates employed in this trial was about 55 tons. The plates were connected all parallel in each cell, the cells in each shoot connected in series, and the four shoots parallel. The electrical energy employed was 50 amperes at a pressure of 50 volts, or a little over 4 i.h.p. Each of the shoots was connected by conductors with a distribution board and suitable switches in the engine-house, in order to enable the operator to reverse the current of any one shoot when desirable. This reversal of the current was carried out upon one shoot at a time, the other three shoots taking temporarily the whole flow of the sewage. The poles of the shoot in question being reversed, the cells in that shoot were short-circuited, which at once caused a very rapid discharge of the back current. After this had taken place the current was reapplied in the opposite direction through a resistance coil, and the resistance gradually cut out as the normal electrical conditions were established. This is, of course, an easy matter for anyone having the most elementary knowledge of electrical matters, and should present no difficulty in practice. The treated sewage then flows into the 10 settling tanks (two sets of five) shown in the plan, each tank being 8ft. wide, 16ft. long, and about 5ft. deep. The sewage flowed continuously through one or other of these sets of five tanks, and over the intermediate walls of each tank, which were provided with double lips in order to assist the oxidation of the effluent. It was found that the production of wet sludge was at the rate of 17·5 tons per million gallons of sewage treated. The suspended matter is principally hydrated ferric oxide, and practically free from organic matter of an objectionable character. The amount of metallic iron used is about three grains per gallon of treated sewage, and nearly all this is present in the sludge as hydrated ferric oxide. Experiments were carried out with this sludge, by burning it under proper conditions, when it was found that a red oxide of iron was obtained which could be converted into a pigment. Possibly this pigment may be so produced in a satisfactory condition and disposed of at a price which will cover the cost of production, and thus get rid of the sludge.*

"The suspended matter was removed by passing the settled effluent over the ordinary sand filter-beds shown in the plan, and it was found that the filters did not become choked at all, but retained their efficiency from October 1891, to the end of the trial in March, 1892. I think that this process has a good future before it, because electrical plant and machinery is being rapidly cheapened and improved every year. From a scientific point of view the process leaves little to be desired.

Visits of Municipal Engineers at Bury.

Among the visits arranged, two were of interest to electrical engineers—viz., to Messrs. Musgrave and Sons mills at Bury, where Messrs. Holmes and Co. have installed the electric light, and to Messrs. Mather and Platt's works at Salford. Although the installation at the mills of Messrs. Musgrave and Sons has been previously described, it may be well to recall it.

The power for driving the dynamos is obtained from two vertical engines, made by Messrs. John Musgrave and Sons, Bolton. The dynamos, two in number, are driven from the engine flywheels by means of cotton ropes. They are of the well-known Castle type, manufactured at Newcastle-on-Tyne, and the latest improvements, both in mechanical and electrical details, are embodied in their design. The output of each dynamo is 46,000 watts, or 62 e.h.p., which is equivalent to lighting 770 16-c.p. lamps; the speed is only 550 revolutions per minute. With slow speed there is less wear and tear on the bearings, commutator, and brushes than with high-speed dynamos. It means an increase in first cost, as the output of a dynamo varies almost directly as the speed. The electrical efficiency of these machines is high—viz., 95 per cent.—and the commercial efficiency is 90 per cent. The dynamos are compound-wound, so that the electrical pressure is the same for any number of lamps that may be burning from about 5 per cent. to the full load. The field magnets of the Castle dynamos are massive and of the best wrought iron obtainable carefully annealed; this secures a very intense magnetic field, which is one of the chief reasons for the high efficiency obtained. The armatures are built up of thin iron discs of the softest Swedish charcoal iron, thoroughly annealed and mounted on carefully-turned gunmetal centres, notches being made in the discs to obtain positive driving. The conductors used on the armature are of high-conductivity copper, drawn and put together in a special manner, by which Messrs. Holmes and Co. claim to get about 20 per cent. more copper into the space than is possible with ordinary methods of winding. The electrical resistance of the armature is much reduced by this method of winding, and this is another reason for the high efficiency obtained. The periphery of the armature is carefully bound with bands of wire to withstand the centrifugal force resulting from rotation. Sight-feed lubricators of the Castle pattern are used. This lubricator consists of a syphon arrangement, and when the drip is once adjusted to the required number per minute it need not be interfered with afterwards, as there

* For the chemical and engineering results obtained from the working of the electrical process, I must refer you to the report of 1891.

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THE TRAMCAR SERVICE OF GREAT BRITAIN.

We have in this journal done our best for the last two or three years to force the attention of engineers to the vast field that lays ready to their hand in the employment of electric traction on our tramways. We have given great prominence to the description of experimental tracks, to articles upon the adoption of electric locomotion through our streets, to the record of progress on the Continent, and especially in America, where the introduction of electric tramway lines has been one of the most striking events of modern practice. We wish now to emphasise one or two points from the public point of view, which it will be necessary seriously to consider as guiding the policy of the next few years. The signs of the times point at last to a considerable awakening of both the public and the technical and financial directors of tramway enterprise to the advantages of electric traction, and there are several concomitant advantages which may well be wrought out at the time of the promised extension of the new method of traction.

When we look back some eight or ten years to the state of tramway investment, or, as they are termed in the States, street railroads, we find an enormous improvement in the general status of the industry. The stocks of tramway companies were looked upon as a poor sort of investment, hardly worthy of being considered substantial; the byword was one of standing jokes of bob-tailed cars and kicking mules; the cars themselves were dingy, small, slow, and uncomfortable vehicles of travel. When the electric motor appeared on the scene, the early innovators fortunately appreciated the sound nature of the investment they had chosen to revolutionise. They saw indeed that tramways were but railways, and railways under the best of conditions—stopping frequently, passing through crowded residential and business districts, constantly full, and of great carrying capacity in proportion to the outlay for plant. They realised then the need for a complete change in the attitude of the public mind towards tramways. The electric cars which replaced the old horse cars were built on an altogether different model of size and comfort. Well-built handsome cars, clean, airy, luxurious even, took the place of the dingy crawlers. The service was organised on a time-sheet service, the officials were uniformed, and trained to be courteous, clean, and attentive. The combination of handsome cars, quick service, and courteous, uniformed officials has transformed the investment into one of the most solid, the best paying in the market; and street railway stock is now quite as much sought after and pays equally good and substantial dividends as the corresponding railroad companies. Listen to what Mr. Geo. W. Hommell, the manager of the Milwaukee Street Railway, has to say upon this point in a letter recently printed in the *Street Railway Journal*: "When I first came to this city from New York, some four years ago, we had very old-fashioned horse and mule cars, and you can well imagine how odd they looked to me. Our business was comparatively small (so were the cars), but now we have our lines almost completed with

others apply it more widely. Now we are quite sure manufacturers will agree with us when we say that. with only one or two exceptions, electrical apparatus is sold with only the ordinary manufacturing charges added to the prime cost. Take the heavy items, there is no extra charge due to patents on dynamos, motors, or transformers. We are quite sure, from personal knowledge of the manufacture of excellent accumulators, that the charge to the buyer includes but a very small percentage, if any, of the price due to patents. It is a mistake for purchasers to suppose that in this year of grace patents add much to prices quoted. Probably incandescent lamps and meters are the only direction in which patented articles cost more than unpatented articles of a similar character. The incandescent lamp is as yet a monopoly. Its price is probably higher than will be the case when the patents expire. But, after all, the ordinary consumer is not now highly taxed because of patents in this case. Nor is he in the case of a meter, as usually only one meter is required in one house. The grumble of the manufacturer is that prices rule too low, that an ordinary manufacturing profit is hardly attainable; and companies saddled with a capital largely watered through payments for patents cannot pay a moderate dividend, because they cannot increase the charges. We trust that purchasers will soon disabuse their minds of the error. Those with a knowledge of the cost of materials and of engineering work will easily see our contention is correct, and that in few, very few, cases "do they have to pay any patent tax."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard"

ELECTRIC TRACTION.

Sir,—With reference to my paper on "Electric Traction," read before the Tramways Institute of Great Britain and Ireland on 28th ult., and published in your issue of 1st inst., my attention has been drawn by Mr. Greathead, M.I.C.E., to the statement that the "system of tunnelling is somewhat novel, and was introduced into this country by Mr. Greathead," is an error.

Under date of 12th inst., Mr. Greathead writes me as follows: "You are in error in supposing that the system of tunneling with a tubular shield was first suggested in America. Beach's American patent was taken out when the Tower Subway (begun in 1868) was more than half driven under the Thames, and long after the shield used in that work had been described and illustrated in English journals (facts which must have been well known to the editor of the *Scientific American*)."

Kindly insert this letter in your next issue, and oblige.—Yours, etc.,
G. A. Grindle.

7 and 8, Great Winchester-street, E.C., July 14.

P.S.—I may add that the statement in my paper above referred to was taken from the records of the Patent Office.

Electric Mining Locomotive.—A 10 h.p. electric locomotive has been used at the Hillside Coal and Iron Company, of Scranton, Pennsylvania, for three years past. The following is its performance for a sample day, Dec. 14, 1891: Distance of round trip, 5,284ft., average time, including stop to take out sprags, 10 minutes, number of cars per trip, 19, trips per day, 30; miles run per day, 30; total running time, five hours; delay, off rail 1¼, and other time 3¾ hours, total hauled, 784 tons. Engine replaces seven mules and six drivers.

THE ALTERNATE-CURRENT DYNAMOS.

BY R. W. WEEKES, WHIT.SCH.

Although the first dynamo-electric machines manufactured gave alternating current, the alternators exhibited 10 years ago at the Crystal Palace were destined to be quickly superseded by direct-current dynamos, which were then being rapidly perfected. A few alternators separately excited by Gramme dynamos were at that time put down in some private installation and used in conjunction with the first Swan lamps. This system soon fell into disuse, as it entailed extra expense and more machinery to keep in repair than the direct-current system. The discovery of the practical advantages of the transformer about seven years ago led to the rapid development of the new alternate current system of distribution, and consequently the design of an efficient alternator is of great interest. The tendency is to build machines for large outputs for central stations, but a few smaller machines are required for the periods of light loads. Several of the makers only exhibited their smaller alternators, but they illustrate the principles of the design as well as the larger sizes.

The alternators made at present can be split up into two characteristic divisions: First, those in which the magnetic lines have a fixed path of constant resistance, and the E.M.F. is produced by conductors intersecting this path; second, those in which the resistance and shapes of the magnetic circuit is varied, and the E.M.F. is produced by the change of induction caused by this.

The first class includes all the older designs, and may again be subdivided into two divisions—*i.e.*, those alternators which have moving armatures and fixed magnets, such as the Siemens, the Ferranti, and the Kapp; and those in which the field magnets revolve, as is the case in the Elwell-Parker, the Mordey, and the Fricker. In all these machines collecting rings are needed either for the armature or the exciting circuit, but as no commutation is required the collectors can be easily designed to run cool and sparkless.

In the second class of alternators the collectors can be dispensed with, and the manufacturers of these machines make this fact one of their claims for support. The Kingdon inductor, exhibited by Messrs. Woodhouse and Rawson, was the only machine of this class at the Palace.

Another way in which alternators have been classified is as to whether they have iron in their armatures or not. The next conclusion being that those which have no iron in the armatures had no self-induction. This error has been dispelled by the aid of the Ayrton and Perry secohm meter, as it was found that the self-induction of the Mordey armature was of the same order as that of those having iron actually in the armature. The disadvantage of the use of iron is that the change of induction in it is frequent, and consequently the loss from hysteresis may become large. This is a valid objection, but owing to the low induction used in the armature iron and to the small amount required, this loss can be reduced to about 1 per cent. of the output by careful design.

The following are the principal requirements which have to be considered in a good alternating-current dynamo to be worked at a high pressure: (*a*) Perfect mechanical design to ensure that the machine can be run continuously; (*b*) strength and stability in the armature; (*c*) perfect insulation in the armature coils, and arrangements so that little difference of potential shall exist between two adjacent parts; (*d*) ease of repair of a defective coil when needed; (*e*) the collecting gear should give no trouble; (*f*) efficiency.

I propose to describe the construction of the different machines in the order given above, and finally to give a tabulated list of them and their details as to output, weight, etc., for a means of comparison.

Messrs. Siemens Bros. and Co.—The alternator exhibited by this firm is of the low tension type, and is similar to the earlier machines made by them. There are in it many improvements over the original design. The magnets are constructed with wrought-iron cores, fitting into the cast-iron frame, which is cast in two halves and clamped together. The exciting coils are wound on brass bobbins, and so connected that the adjacent poles round the frame have always opposite polarity, and also that any two

It is in the armature design that this machine has been so much perfected. The cores round which the conductor is wound are made of laminations of brass and asbestos. The radial brass strips have a longitudinal corrugation pressed in them, so that when placed together these form keys to prevent any individual strip being displaced. The thickness of the asbestos between the laminations is increased along the radius so as to give the necessary angle to the core. When the core is built up to correct angle and thickness it is clamped firmly, and a brass connection is burnt on to the thin end. This is done by running molten metal over the ends of the strip till they fuse together. The core is then machined at both ends to the proper shape, and the solid brass end is drilled for the bolt, which acts as an electrical and mechanical connection. The inside end of the copper conductor is brazed on to this solid end. This copper strip also has a corrugation in it to prevent side displacement, and is wound bare with a strip of fibre as insulation between the succeeding turns. A large strain is put on the strip while being wound, and this forces the insulation well into the groove, which securely keys the turns together. In mounting the coils, one carrier is provided for each pair of coils, as shown in Fig. 2. There is a sheet of fibre insulation on each side of the coil when placed in the carrier, but the bolt which secures the coil *in situ* also connects the inner end of the conductor to the carrier. Hence the carrier connects the two inside ends of the coils it holds. The outside ends of the conductors are joined where the coils in adjacent carriers touch. This is done by brazing the two outside ends together before the coils are fixed into position. With this system of connection, it is clear that the individual carriers must be well insulated both from the frame and from each other. This is done by a process of casting in with a sulphur compound. The shank of the carrier is first insulated with porcelain where it passed into the hole in the driving ring. This ring is hollow inside, and a large rectangular nut is then keyed on to the shank so that it leaves a small space all round. A sulphur compound is then run into this place, and both firmly clamps the nut by expansion and also insulates it. The porcelain insulation is used to give a greater surface insulation, and also for fear a spark should ignite the sulphur if it was exposed. The two halves of the armature are connected in parallel so as to reduce the maximum voltage between any two coils.

In the present 245-kilowatt machine, when working at 2,400 volts, we get 200 volts produced in each bobbin, and hence a maximum difference of potential of 400 volts between the two adjacent bobbins in one carrier. At this place ebonite strips are introduced to tighten up the armature coils, and these strips thus give special insulation where it is needed. The lower ends of the coils are blocked up in the carrier by means of insulated metallic segments, shown in the sketch. This method of connecting the armature is exceedingly convenient in case of repairs being needed. If one coil should be injured by any mishap, it and the one next it in the adjacent carrier are unclamped and lifted out together, and the connection is completed to two new coils by the simple operation of bolting them into place. The connections from two diametrically opposite points on armature are taken through the inside of the main shaft to two well-insulated copper rings. The collectors used are two half rings of brass, with blacklead introduced to give the necessary lubrication and conductivity at the same time. The field magnets of this machine consist of wrought-iron slabs cast into the frame of the machine. The frame is built up in segments, and when bolted together they embrace the armature. The exciting coils are wound on formers and slipped on, being secured in places by the pole pieces. The oiling arrangements are exceeding well devised. The oil is forced up in the bearing at the underside of the shaft, and so tends to float it. The oil pumps at either end are worked by means of eccentrics fixed to the shaft.

The efficiency of the machine should be high, but although the lamination of the core will reduce the Foucault currents in the brass strip, it is probable that this loss will still be higher than the hysteresis loss in an iron-cored armature. The brass, however, gives exceptional stability to the armature. The power required to excite this machine is supplied by a current of 150 amperes at 30 volts, which is equal to 1·85 per cent. of the total output.

The following are the details of the alternator: Volts 2,400, amperes 100, speed 335; complete periods, 66 per second; number of bobbins, 24; conductor, 1 millimetre by [illegible] wide; number of turns per bobbin, 40; insulation, vulcanised fibre, ½ millimetre thick; weight of armature conductor, 250lb.; area of pole face, 126 square inches; exciting coils wound with 522 turns of 3·91 millimetre copper; weight of whole machine, 18 tons 7cwt.; floor space, 9ft. 9in. by 13ft. 8in.; height, 9ft. 3in.

LONDON CHAMBER OF COMMERCE.

[The following circular letter has been issued in connection with the Chicago Exhibition.—Ed. *E. E.*]

Dear Sir,—As you will no doubt observe from this week's issue of the trade papers, Mr. W. H. Preece, of the General Post Office, attended at the meeting of the Electrical Trade Section of this Chamber on Friday last, and gave reasons why the section should endeavour to co-operate in the organising of a representative British electrical exhibit at the forthcoming Chicago Exhibition. The Society of Arts, as you are aware, are acting as the British Royal Commission for this exhibition, and we are informed by Mr. Preece, as representing the electrical section of that body, that while other industries will send to the exhibition the most magnificent display ever sent by this country to any home or foreign exhibition, the electrical industry has up to now been an exception to the rule, and the articles to be exhibited are not considered to be anything like an adequate representation of the advancement which has been made in the application of electricity in this country during recent years, especially, too, as we believe the amount of capital invested in England has enabled developments to be made which have not as yet been equalled in any other country.

For your information I enclose a list showing the firms proposing to exhibit, the articles to be exhibited, and the space occupied.

Hitherto there has, we believe, been a disinclination to exhibit at Chicago, probably from a feeling of resentment, in the first place, to the McKinley tariff, and, secondly, because, apart altogether from this question, to exhibit there is not likely to result in developing any further trade with the United States. In regard to the first of these considerations, we would point out that if there were to be an entire absence of English exhibits, or even of electrical apparatus alone, visitors would seek for, and no doubt find, a reason for the absence of English exhibits in the McKinley tariff; but as certain firms find it an absolute necessity to exhibit, if they are to preserve the trade which they have already acquired with foreign countries, the question comes to be whether foreign visitors will not be entitled to regard the exhibits there as fairly representative of the state of the electrical industry in England. In regard to the second consideration, nearly all are agreed that the exhibition will not be productive of any trade with the United States; but in view of what has just been said, is it not desirable, in the interest of British foreign trade in general, that the industry should combine to make a representative exhibit? Such an exhibit would impress foreigners with the progress which has been made in this country in electrical science, and might possibly result in inducing them to make application later, if need be, to English firms instead of patronising nations who have created a better impression in consequence of a better display. Further, the various articles comprising the exhibit can be labelled prominently with the name of the makers, so that the exhibit will be personal as well as representative of the industry as a whole.

Mr. W. H. Preece suggests that this object might be accomplished by a certain number of firms combining as a syndicate to furnish a suite of rooms, and to have them decorated and lit up by electricity in the manner common to English houses. The expense would, of course, in this case be shared proportionately. If a response to this circular is received which would warrant our prosecuting the matter

further, then the Chamber would make an effort to secure the co-operation of the Furniture and Textile Trade Sections in supplying furniture, carpets, curtains, etc. In such an event the expense to each individual firm would, of course, be reduced proportionately. Mr. Preece has no doubt that the Royal Commission would be prepared to take charge of the exhibit, though possibly exhibitors would prefer to appoint someone to take charge of the exhibit who might be paid a commission on the sales. Free space has been provided, and only 5,000 out of the 20,000 square feet provided for electrical exhibits has as yet been allotted.

In order that we may know how far we are likely to be supported in endeavouring to carry out such a scheme as has been here indicated, I should be glad if you would fill up the enclosed form and return to me at your earliest convenience.—Yours faithfully,

KENRIC B. MURRAY, Secretary.

Questions.

1. Are you prepared to exhibit at Chicago on the lines indicated on the enclosed circular?

2. If so, what sum are you prepared to guarantee, it being understood that you would only be called on to subscribe proportionately, the proportion, of course, depending on the number of firms coming forward?

3. What would be the nature of your exhibit, and the amount of space you would be likely to require?

WHITEHAVEN.

Dr. J. Hopkinson, F.R.S., the consulting electrical engineer retained by the Whitehaven Board of Trustees Electric Lighting Committee to advise upon the question of electric lighting for the town, has sent in the following report:

On Friday, the 24th day of June, I visited Whitehaven, met your committee, and carefully examined the special conditions of Whitehaven in regard to electric lighting. The first point to be considered is the position of the generating station, for upon this will depend the choice of the system of lighting to be adopted. If the electric lighting station were established on the site of the present pumping station, which is close to the docks, a great deal would be saved in wages and a great deal also in coal, for it would only be necessary to keep up steam in one place to serve the two purposes of pumping and generating. I am therefore decidedly of opinion that the generating station should be placed upon the site of the pumping station. The demand for lighting in Whitehaven can never be very great, for I estimate that the whole of the gas accounts can never amount to more than about £8,000. The Trustees' order requires that they shall keep a supply during the whole 24 hours. If accumulators are not used, this will necessitate the presence of a staff of men at the generating station at all times. If, on the other hand, accumulators are used there will be many hours at all times of the year when the machinery might stand, and in summer it would be certainly unnecessary to run more than about six hours out of the 24. I therefore advise that in the case of Whitehaven, the three-wire system should be adopted, with accumulators for use during the hours when the demand is small. The price of gas in Whitehaven is 3s. 6d., and the quality I am told is inferior. Sixteen-candle gas at 3s. 6d. is equivalent to a supply of electricity at 5½d. per unit or thereabouts. I have no doubt that on anything like a reasonable scale electricity can be supplied at less than this cost, and, therefore, there is no reason to doubt that if the committee decide upon putting down a plant sufficient to supplant a considerable fraction of the gas supply and to charge a price not exceeding that which is now demanded for gas, they will obtain a considerable demand, and when sufficient time has elapsed for the light to be properly taken up will cover all their expenses, though they will not be likely to realise any very large profit. I have made an estimate of the cost of the plant which I would recommend, and upon this some explanation will be useful. It is proposed in Whitehaven to light up the bulk of the street lamps in the central part of the town by electricity. This can be done, and not unprofitably, for the hours during which these lights are used are considerable, and it is now an admitted axiom in electric lighting that a supply can be produced at much less cost when the hours during which it is used are considerable than when they are short. But the cost of arranging conductors underground for a comparatively limited number of lamps placed a considerable distance apart is considerable. This cost lies not so much in the main leads which convey the current as in the necessity for taking up a great length of streets for the purpose of laying one or two small wires to reach the separate lamps, so that these lamps can be turned off and on at the generating station without the necessity of a lamplighter going round to turn on and extinguish the lamps. The supply of electricity to the street lights is a perfectly definite problem, for one knows precisely the demand and one can arrange to meet it. It is not so with the general supply in the town to private customers, for these we must proceed on what I can only describe as a guess. In my estimate I have provided three pairs of feeding conductors, one pair capable of carrying 300 amperes, and therefore of supplying 1,000 16-c.p. lamps to the corner of Lowther-street and King-street, with distributing mains from that point; another pair for 500 lights to Corkickle, with distributing main; and a third pair for 500 lights to the neighbourhood of the hotel near to the station. The extent to which these conductors will be utilised will depend upon the extent to which the light is taken up. For example, in the last case the railway station would be a very considerable customer if they decided to take the light. For generating plant I recommend Willans engines, by which means the Corporation can get into the present available space at the pumping station sufficient power to supply the whole of the town, without any material structural alterations beyond what may be required for foundations for the machines. The size of engine selected is that which will give 60 i.h.p. when working at its maximum capacity. The rest of the items in the estimate explain themselves. The conductors provided are intended to supply 2,480 16-c.p. lamps, of which 408 are in the streets. Each engine in the generating plant will supply 500 lamps, and the battery will supply 330. The cost of adding additional power would be slight; it would be limited to additional engines and dynamos and additional feeding conductors. I have also made an estimate, given below, of the cost of working this station. This shows a total annual cost of £1,947. 10s. I have also made an estimate of the probable revenue to be derived from the sale of current and other sources of revenue. The first item in this account is a sum of £400 for the services of the pumps, the amount which, I am informed, is now expended in wages and coal. It further includes a sum of £800 for public lighting, for which will be given a very much better light than at present. The amount to be derived from the supply of electricity to private consumers is a much more uncertain item, as one can only guess at the number of consumers you will have and at the number of hours during which they will take their supply. A convenient method of charge is one which I recommended in Manchester, and which is intended to secure that consumers who use their light for many hours in the 24 shall be charged at a less rate per unit than those whose user is more brief. It is proposed that for each unit of power in the maximum power demanded by the consumer a charge not exceeding £3 per quarter be made, and in addition for each unit supplied a charge not exceeding 2d. For the present purpose, however, I assume that the average charge to the consumer is 5d. per unit, and that the average number of hours per annum during which the supply is demanded is 750, and that the conductors are used to three-quarters of their proper maximum current. On this basis the average revenue is £2,606, showing a profit of over £600. These figures satisfy me that if the committee adopt the bold policy of putting down adequate plant and adequate conductors, and charge a price something less than the present price of gas, they will be certain to secure such a demand for their supply as will render it remunerative.

5, Victoria-street, S.W., 6th July, 1892. J. HOPKINSON.

CAPITAL OUTLAY.	£	s.	d.
Structural alterations of buildings	300	0	0
Conductors for street lamps, laid	2,097	0	0
Fixing for street lamps, without lamps	204	0	0
Conductors for house lighting	3,319	0	0
Two boilers of about 250 h.p. each, set	1,200	0	0
Four Willans condensing engines, type FF, and steam-pipes, at £350	1,400	0	0
Ejector condensers, at £20	80	0	0
Tank and pumps	200	0	0
Four dynamos at £400	1,600	0	0
Accumulators for 100 amperes and 200 volts at lamps	700	0	0
Switchboard and instruments	200	0	0
	£11,300	0	0
Contingencies and engineering	1,130	0	0
Total	£12,430	0	0

RUNNING CHARGES.	£	s.	d.
Wages	500	0	0
Coal	200	0	0
Water and stores	40	0	0
Maintenance of accumulators	87	10	0
Maintenance of machinery and conductors	250	0	0
Interest and sinking fund at 7 per cent.	870	0	0
Total	£1,947	10	0

PROBABLE RECEIPTS.	£	s.	d.
Pumping	400	0	0
Public lighting of 408 lamps	800	0	0
Private lighting—Supply is 600 amperes at 200 volts or 120 units per hour. Take three-fourths of this for 750 hours per annum at 5d.	1,406	0	0
Total	£2,606	0	0

At a meeting of the Electric Lighting Committee, held last week, a letter from Dr. J. Hopkinson was read, in which he stated that he would superintend the erection of the works in accordance with his report for a commission of 5 per cent. on cost thereof. It was resolved that Dr. Hopkinson's report be adopted, and the committee recommended that the Trustees apply to the Local Government

Board for sanction to borrow £14,000 for purposes of electric lighting, and that Dr. Hopkinson be engaged to carry out the works on the terms named in his letter.

GRIMSBY ELECTRIC LIGHTING.

At a meeting of the Lighting Committee last week, the borough surveyor read the following report from Prof. W. Robinson upon the electric light installation:

In accordance with the instructions dated the 25th May, 1892, I have the pleasure to report that I attended at the Town Hall, Grimsby, on the 2nd June, and made careful tests and examination of the Crossley gas engine, Roper dynamo, and whole electric light installation.

Driving Gear.—I found the gas engine driving the dynamo, which gave a current of 150 amperes strength at 105 volts pressure, supplying all the glow lamps and one arc lamp. This load of lamps, taking about 21 h.p. effective output at the dynamo, required considerably more power from the gas engine, because of the excessive vibration of the belt and unsteady driving. The speed of the engine was found to vary between 188 and 192 revolutions per minute, causing the dynamo to run between 723 and 729 revolutions per minute, and a corresponding variation of two volts, in the electric pressure, from 104 to 106 volts was clearly indicated by the voltmeter. The diameter of the driving flywheel is very nearly 6ft., and that of the driven pulley 1ft. 6in., and the distance between the centres of their shafts is only 11ft. The short drive of 13ft. 6in. given in the original plans has been reduced to this still shorter drive of 11ft. by turning the engine round from the proposed position. Further, I found the bearings of the shaft carrying the driven pulley, heavy disc, and dynamo in an unsatisfactory condition. One bearing of the dynamo was heated, although well lubricated; also the journal and pedestal near the heavy disc were quite shaky, the brasses being kept loose to prevent overheating, and the pedestal and journal were not nearly large and massive enough for the power, speed, and driving conditions. The fast and loose pulley mentioned in the specification has been replaced by a pulley provided with flanges 3½in. deep, in order to keep on the driving belt, which was frayed on one edge, due to working against the flange, showing that the belt tends to slip off the pulley. The belt appeared to be made of "Scandinavia" cotton belting, pliable, strong, and well suited to the work, because it runs more smoothly and quietly than leather. I am of opinion that the tendency of the belt to be thrown off the pulley is due to three causes. First, the great difference in size of flywheel and driven pulley combined with the comparatively short distance between their centres; second, the sudden fluctuations in rim speed of flywheel of engine from one explosion in the cylinder to the next, especially when there is a miss between them; and third, the side slipping of the belt points to the shafts not being truly parallel. Anyhow, the driving is unsteady and unsuitable for electric lighting, and the shafting needs alteration.

Dynamo Machine.—After two hours' run with the above load, taking a current of 150 amperes, the rise in temperature of the coils of the dynamo was found to approach close to the limit of safety, which would certainly be exceeded were the current to become 250 amperes as marked on the brass plate on terminal board of the machine. In fact, dangerous overheating and consequent breakdown of the installation would be produced by a constant current much above 200 amperes maintained for several hours, and the dynamo is not capable of producing and maintaining an electrical output of 30,000 watts at 110 volts under ordinary working conditions as set forth in the specification. I do not advise you to put on the dynamo more than 300 lamps taking 180 amperes, which is about the maximum safe working load at 110 volts; that is, the maximum output is about 20,000 watts, or two-thirds the power specified.

Range of Ammeter.—I consider the ammeter, reading up to 400 amperes, is unsuitable for the present requirements of the installation. Since the greatest range of current marked on the dynamo is 250 amperes, an ammeter reading up to this limit would be more serviceable than the present one; moreover, the normal working current of 150 amperes at present taken from the machine could then be indicated more clearly on the scale of the instrument, and read with greater accuracy.

Voltmeter.—I tested the voltmeter by comparison with a standard Cardew voltmeter, and found it correct.

Gas Engine.—The gas engine was tested with a rope brake on the driving flywheel. The first trial was running light, next with the load gradually increased from 9 h.p. to 28 h.p., and finally with full load, the gas supply being adjusted to keep the speed at 192 revolutions per minute. The mean of the full load tests was at 33 actual horse power, and the maximum reached was 38 effective horse power on the brake at 192 revolutions per minute. The mean gas consumption observed was at the rate of 31 cubic feet per effective or brake horse power per hour throughout the trials. The engine behaved well, fully coming up to the terms of the specification, and capable of giving out greater power than required by the dynamo.

Electrical Tests: Insulation Resistance.—The electrical resistance between the two leads, as well as the resistance between each lead and the earth or ground, was tested by means of a Wheatstone bridge, with the following results: Resistance between two leads, about 2,000 ohms only; resistance between positive lead and earth, also about 2,000 ohms; resistance between negative lead and earth, about 90 ohms. The above values of the insulation resistance were obtained with a battery of only two Hellesen dry cells. The dynamo was next run at its normal speed, giving 105 volts of pressure at the terminals, and a current of about 150 amperes. One terminal of a Cardew voltmeter was connected to a gas bracket, and the other to a wire which was connected to both terminals of the dynamo in succession. When joined to one of the terminals, the voltmeter gave a reading of 105 volts, showing and proving that one of the mains must have been "earthed." The same experiment was repeated, but using a water-pipe for "earth" instead of the gas pipe, with the same result as before. The above tests prove conclusively that the insulation of the installation is in a very unsatisfactory condition, and requires immediate attention. The main lead to the double switch on switchboard in the engine room was also found to be "earthed" somewhere. This is against the Board of Trade regulations, and attended with danger to public safety.

Arc Lamps.—On examination of the arc lamps the resistance coils used in series with these lamps were found to be in a bad condition, and were in contact with the iron frame supporting them, which was fixed to the outside wall and exposed to the weather, pointing to the probability of the leakage to earth occurring there. This arrangement of the resistance coils outside the building, exposed to rain, snow, frost, etc., is calculated to give serious trouble, especially in winter, when the light is most wanted, since the coils might readily be short-circuited and the current leak to earth, and thus interfere with the proper work of the whole installation. It would, therefore, be highly advisable to place the coils in special boxes, so as to ensure good and high insulation, else the arc lamps cannot be relied upon to burn properly.

General Fittings.—The electroliers are excellent. Although the specification states (page 6) that the "wiring and installation throughout is to be carried out in accordance with the rules of the Phœnix Fire Office," these rules are ignored in the specification itself, where the existing gasoliers are proposed to be used, evidently to keep down expenses, and yet rule 23 is to the effect that "gas fittings should never be utilised for the electric light, and they "must not be used without special sanction." Furthermore, I advise that at least ceiling roses for insulation should also be placed wherever conductors are led down from the ceiling to the existing gasoliers, instead of the bare holes in the plaster with the conductors passing through. In order to be safe against fire risks it is highly desirable to have the installation approved of by the inspector of your fire insurance company, because my experience of the Phœnix Office is that your installation is not fit to be passed. Even the highest value of the installation obtained by the above tests is far below what the insulation resistance of the whole installation should be, and the tests prove conclusively that the mains are practically joined to earth when the ordinary working electric pressure is applied, and therefore require immediate attention and repairs. The inevitable conclusion to be drawn from the above facts and figures, as the results of my tests, is that the installation in its present state is not a first-class job, and the electrical part especially is incomplete, not being in proper working order, and has not been carried out in accordance with the terms of the specification. I should strongly advise you to use accumulators as reservoirs and regulators: first, to keep some lights, as at the police department, going all night, and as a reserve in the event of a breakdown of machinery, bursting of ignition tube, etc.; and second, to steady the light and prevent blinking or winking caused by the irregular explosions in the gas engine cylinder and throb of the driving belt. (Signed) WILLIAM ROBINSON,

Professor of Mechanical and Electrical Engineering.

The **Chairman** remarked that so far as the actual working of the light was concerned, they had quite sufficient evidence upon that point. They knew that the light jumped and at certain periods was not satisfactory, and it seemed to him that an explanation of the defect was to seen at once in the opening of the inspector's report. They must be right with the engine, however much they might be at fault in other departments. If they were not right in the first instance—in the motive power—they could not be right anywhere. The inspector had pointed out what had been in his (the chairman's) mind for a long time—that the unsteady driving they had at present was more expensive than smooth running. He was perfectly willing to subscribe to everything stated in the report upon this point.

The **Borough Surveyor** pointed out, on the subject of the dynamo, that the cheapest course would be to put in a new one altogether.

The **Chairman**: If the contractors have supplied a dynamo two-thirds the strength required, they must take it up and put down one of the full strength.

Mr. Connell said that would not be an expensive matter. It would simply be a case of substituting another dynamo, and taking back again the one at present in use.

The **Chairman**, after some further discussion on matters of detail, remarked that their business was to pass a resolution calling upon the contractors to carry the work according to the specification and to finish it properly. If they would not finish it, it remained for the Corporation itself to conclude the work and debit it against the contractors. Therefore he moved that the town clerk write calling the attention of the contractors to the fact that the specifications had been seriously departed from, and stating that it was required they should at once do what remained to be carried out.

Mr. W. Mudd seconded the proposal, which was agreed to.

It was decided that the borough surveyor should report as to what was the value of the alterations and electrical fittings at the Town Hall, in order that the insurance might be arranged for.

ACCUMULATORS NEEDED.

The **Chairman**, referring to the last clause in the report, said he had always been of opinion that their installation would never be complete unless they had accumulators especially if they intended to light the police department with electricity. He believed it would be economic if the Corporation arranged to procure accumulators that would run the light for three hours. They would be particularly useful with respect to committee meetings and the requirements of the surveyor's office even the Council chamber as well. None could deny that the electric light was an improvement upon the old system, and when they had everything completed he had not the slightest doubt that it would be more economic and satisfactory.

The **Borough Surveyor** stated that from enquiries he had made he thought £300 would leave sufficient margin for getting all that was required.

The **Chairman** said it had been thought they could get a very fair set of storage apparatus for about £100.

The **Town Clerk** reminded the committee that it was a question also of renewal.

The **Surveyor** stated that the company with which he had been in communication were agreeable to attend to the accumulators for a time not less than five years at a charge of 10 to 12½ per cent. per annum on the total cost. That would be about £35 per year.

The **Chairman** said that question required careful consideration. It might very well stand over until the next meeting.

The **Surveyor** had found that in nearly every case where the electric light had been adopted accumulators were in use.

The **Chairman** said there was absolutely very little cost in the manufacture of the accumulators; the high price was on account of the tax put upon them by way of patent.

The surveyor was instructed to procure further information upon the subject.

LEGAL INTELLIGENCE.

THE MEDICAL BATTERY COMPANY v. JEFFERY.

Harness's Electropathic Belt.

Mr. C. B. Harness, of electropathic belt fame, has at last met an opponent with the courage of his opinions upon a disagreeable experience, and has been badly thrown in the encounter. The case came before Judge Bacon at the Bloomsbury County Court on Tuesday, the suit being The Medical Battery Company v. Jeffery. The claim was for £3. 5s., balance of account for a five-guinea belt (the same kind, by the way, that Dr. Silvanus Thompson declared had no value "except in the flannel"). A counterclaim was put in by Mr Jeffery for his I O U. for £3. 5s. and the return of £2 paid, on the ground of misrepresentation, and that no good consideration was given for the money.

The defendant, a bank clerk, came to the Electropathic Institute thinking he was suffering from a sprain, and would require a truss. He asked for a qualified man, and was introduced to Mr. Simmonds, who advised him to wear a belt price £5. 5s., and so prevent rupture. The sum of £2 was paid, and an I O U given for the remainder. Later, Mr. Jeffery complained of the belt, as it caused sores and aggravated the complaint. He had consulted a medical man, who ordered him to leave it off as in no way suitable for rupture. He was met with request for payment. He then instructed Messrs. Lewis and Lewis to proceed for return of the money, but found that proceedings had already been taken by the company. The counterclaim was then entered.

Mr. Frederick Thomas Simmonds, examined, stated that he had had great experience in fitting trusses, having attended over 16,000 cases. He was therefore a qualified man, though not a "qualified medical man." The defendant was not absolutely ruptured—only internally. He (the witness) recommended an electric belt to give "tone" to the system. He had been employed in the company for seven years, and began treating hernia after he had been there three months. Before that he was salesman in an Oriental furniture warehouse, but had studied hernia since he was nine years old. There was protrusion of the bowel through the internal ring in this case; he did not know what effect the electricity would have. The belt, weighing 2lb. or 3lb., was, he considered, the proper one for internal hernia. They had 500 in stock. The patient would not require more electricity than he could get out of the belt. "Is there any electricity here?" "Yes." "Do you pledge your oath that there is an electrical current?" "I have no knowledge of electricity. I have sufficient knowledge to know it would be useful." "Would the patient get a serviceable amount of electricity?" "Yes, certainly, as the moisture of the body would complete the circuit." "What is the cost price of the belt—15s.?" "I have nothing to do with the cost of the goods. I am a little above that sort of thing. Mr Harness had a large number of patients. I am not an electrical expert. I do not know how the current passes."

Mr. Lickfold, addressing the Court, said the defendant was a cashier in the Union Bank, and having, as he feared, ruptured himself, his attention was attracted to an advertisement of the Electropathic and Zander Institute, 52, Oxford street, where medical advice was given gratis. He asked to see a medical man. He saw Mr. Simmonds and told he was suffering from rupture. Mr. Simmonds examined him, and told him he was not so suffering, and added: "You must have one of our belts and that will set you right." The defendant was fitted, and took a belt costing £5 5s. Instead of doing good, the belt chafed the skin and caused an eruption, and the illness was so aggravated that the defendant consulted a medical man, Dr. Rowntree. After going through the facts, Mr Lickfold said he should produce evidence to prove that these so-called electric belts were nothing else than fraudulent impositions. People were inveigled into this trap, and belts, which were absolutely worthless, were palmed on them, and they were ashamed to proclaim their folly by prosecuting the promoters of these impostures. But it was now time that it should be put a stop to. The learned gentleman submitted that there had been misrepresentation in this case, because Mr. Simmonds was not a qualified man, and because he misled the defendant by telling him that he was not suffering from hernia when he was so suffering. Then the defendant was entitled to have his money and I O.U. returned to him, as he had not received any good and proper consideration for his money.

Mr Jeffery was then examined, stating his experience, how a lump in the groin formed afterwards a sore, and that he had then consulted Dr. Rowntree.

Mr William George Rowntree, L.R.C.P., said Mr Jeffery had been suffering from rupture for a month, or even three, when he called. The belt was not of the slightest use. He recommended a truss, and the patient is getting better.

Mr. T. E. Gatehouse was then examined. He stated he was an electrical and consulting engineer of 22 years' practice. He had examined and tested the belt. It was absolutely worthless. As arranged, the belt could produce no electricity at all. The moisture of the body would set up a current between two dissimilar metals, but there must be a complete circuit. There is no completion of the circuit under the belt.

His Honour: Why, would not a body touched back and front and all around complete a circuit?

Witness. As this belt was worn it never produced a trace of electricity. This morning I made an experiment with this belt, so as to produce a small quantity of electricity. I took salt water and moistened the two parts, and then I connected the copper and zinc with a galvanometer, and so I got a slight deflection of the needle of about 14deg. I then put the belt on my legs and on my arms, and the deflection was not in the slightest degree altered. That shows that when these belts are worn by any patient no electricity passes through the body in any way whatever, but only along the webbing of the belt and over the skin surface. Electrically these things are useless.

Mr. Lickfold. Then you say this belt electrically is absolutely a useless article?

Witness. Yes.

Cross-examined by **Mr. de Witt**: Zinc and copper are used in generating electricity.

Do you say that this belt would produce no current at all?

Witness. Not as the defendant wore it. The circuit was not complete! I saturated this belt with salt water and then I got a small electrical current. I say there is a current if properly connected up, but the current will not go through the body—it is the webbing and skin, and not the body, which forms the internal circuit.

This concluded the evidence.

His Honour, in giving judgment, said: I think it is clear, on the evidence, that the defendant went to the plaintiff's establishment and asked to see a qualified doctor. That was uncontradicted. The defendant was shown that the gentleman whom he saw (**the gentleman who calls himself an "expert"; a gentleman** without any medical education, or education in this matter, except having studied the best works on the subject since he was nine years of age), and when he asked for a truss, recommended him something which he said was better. The defendant has shown that this gentleman told him he was not suffering from rupture, **but only from the beginning of rupture. I have no doubt from** the evidence Mr. Simmonds said to the defendant: "**I am happy to tell you you are not ruptured." But that was not the fact; the defendant was ruptured, as I cannot help believing** from the evidence of Dr Rowntree. He went for a truss. He was told, "You do not want a truss." This is a representation made by a man who had not taken the trouble to qualify himself, and who ought not to have made any representation at all. This was the representation which led to the contract, a contract without any good of any sort to the defendant, **and it must be voided. There must be judgment for the** defendant on his counterclaim, and his £2 must be returned to him.

Mr Lickfold applied for costs on the higher scale.

His Honour refused the application. Judgment accordingly.

COMPANIES' MEETINGS.

EDISON AND SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

Directors: James Staats Forbes, Esq., chairman; Major Samuel Flood Page, deputy chairman; the Earl of Lichfield; Shelford Bidwell, Esq., F.R.S., Ernest Villiers, Esq.

Ninth annual report of the Directors presented to the shareholders at the meeting of the Company, held at the Cannon street Hotel on Tuesday, July 19.

The business of the Company has resulted in a credit balance of £74,810 16s. 7d. Of this amount £30,271 15s. 11d. has been already distributed as an interim payment on the A shares for the first six months of the year in respect to dividend and arrears. The Directors recommend a further distribution of a dividend on

the A shares of the Company, of 5s. 8¼d. per share on the 80,261 ordinary shares, £3 paid; of 9s 6¼d. per share on the 5,000 £5 fully paid shares allotted to the Edison Electric Light Company, Limited; and of 8s 10¼d per share on the 12,139 £5 fully paid shares allotted to the Swan United Electric Light Company, Limited, free of income tax, being, with the interim dividend paid on the 22nd February, 1892, 7 per cent. in respect of the year ending 30th June, 1892; 7 per cent., in payment of arrears of cumulative preferential dividend for the year ending 30th June, 1887; and of 4 per cent in respect of the year ending 30th June, 1888; all to be distributed in accordance with the provisions of clause 87 of the articles of association which will absorb £33,354 4s 9d., leaving £11,184 15s. 11d., which the Directors have carried to the reserve fund, in accordance with clause 89 of the articles of association. The Directors are glad to say that their electrical fittings business is prospering. The amount received as royalty from those who hold licenses for manufacturing holders and sockets for incandescent lamps is satisfactory, and is likely to increase year by year. The Directors desire to record their sense of the loss which the Company have sustained by the death of Mr F. R. Leyland. The Directors have elected Major Samuel Flood Page, who had been secretary and manager of the Company since 1883, to fill the place on the Board. The Earl of Lichfield and Mr Ernest Villiers retire by rotation from the Board, and offer themselves for re-election as directors. Messrs. Welton, Jones, and Co., auditors, also retire, and offer themselves for re-election.

PROFIT AND LOSS ACCOUNT, YEAR ENDED JUNE 30, 1892.

Dr	£	s.	d.
Stock on hand, July 1, 1891	59,308	11	5
Wages, purchases, etc	59,001	11	10
Salaries, Directors' remuneration, rent, office expenses, insurance, income tax, general and law charges	16,067	16	11
Depreciation on plant, etc	2,859	14	6
Balance	74,810	16	7
	£212,048	11	3

Cr	£	s.	d
Sale of lamps, fittings, royalty on holdings, etc.	166,348	19	5
Interest, etc	473	11	11
Stock on June 30, 1892	45,225	19	11
	£212,048	11	3

BALANCE SHEET, JUNE 30, 1892.

Dr.	£	s.	d.
Share capital—			
5,000 A shares of £5 each, fully paid, allotted to the Edison Electric Light Company, Limited	25,000	0	0
12,139 A shares of £5 each, fully paid, allotted to the Swan United Electric Light Company Limited, ranking up to 5 per cent for dividend on the amount credited as paid up, and afterwards equally, per share, with A shares partly paid	60,695	0	0
89,261 A shares, £5 each, £3 paid	267,783	0	0
23,564 B shares, £5 each, fully paid	117,820	0	0
	£471,298	0	0
The B shares are entitled to one fourth of the profits, after a cumulative preferential dividend of 7 per cent per annum has been paid on the A shares (The preferential cumulative dividend of 7 per cent. amounted, on 30th June, 1892, to £47,143 16s. 4d.)			
Sundry credit balances	16,493	4	3
Reserve fund	22,077	5	0
Profit and loss as per appropriation account, £74,810 16s 7d; less interim dividend at the rate of 5s. 3d. per share on the A shares, £3 paid, 8s 9d per share on the fully paid shares allotted to the Edison Electric Light Company, Limited; and 7s. 8d per share on the fully paid shares allotted to the Swan United Electric Light Company, Limited, paid on Feb. 22, 1892, £30,271 15s. 11d	44,539	0	8
	£554,407	9	11

Cr.	£	s.	d.
Cost of patents, goodwill, preliminary outlay, loss on working, etc., as per last balance sheet	234,638	17	7
Further expenditure thereon	1,460	3	4
	236,099	0	11
Amount of B shares of this Company, issued as *per contra*	117,820	0	0
	£353,919	0	11
Manchester Edison Swan Company, Limited, Cl,000 B shares at nominal cost	12,000	0	0
Freehold property	39,458	0	3
Plant and stock	67,328	6	7
Office furniture	173	7	8
Debtors	30,809	2	8
Investment in consols at cost	20,000	0	0
Cash at bankers and in hand	30,719	11	10
	£554,407	9	11

STATEMENT SHOWING THE PROPOSED APPROPRIATION OF PROFITS.

	£	s.	d.
Dividend for the year ending 30th June, 1892, at 7 per cent per annum	24,743	9	2
Payment of cumulative preferential dividend on the A shares, for the year ending 30th June, 1887, at the rate of 7 per cent.	24,743	9	2
Payment on account of cumulative preferential dividend on the A shares, for the year ending 30th June, 1888, at the rate of 4 per cent.	14,139	2	4
	£63,626	0	8
(Of which £63,626. 0s. 8d., an interim dividend of £30,271. 15s. 11d. was paid 22nd February, 1892.)			
Reserve fund	11,184	15	11
	£74,810	16	7

	£	s.	d.
Balance of profit for current year to June 30, 1892	74,810	16	7
	£74,810	16	7

The annual meeting of the Edison and Swan United Electric Light Company Limited, was held on Tuesday at the Cannon-street Hotel, Mr James Staats Forbes (the Chairman of the Company presiding.

The **Secretary** (Mr. H. Charles Cover) read the notice convening the meeting. The report and accounts were taken as read. (These we give in this issue, as we received them too late for insertion in our last.)

The **Chairman** said: Gentlemen, I have had occasion before to call attention to the position of a company like this, where circumstances operating upon its interests make it expedient that the accounts should be stated in a manner rather more general than in some other companies which have a statutory form of accounts. I suppose as the day arrives when our patents are running out that reticence becomes even more necessary than in the earlier stages and that is why these accounts are so brief in statement, and are confined to so few elements as compared with the accounts of [illegible] other public companies. The essence of all these accounts is what profit has been made, and how we propose to divide it. I [illegible] remind you of the peculiar position of this Company, and why, however satisfactory the result, as shown upon a particular year, may be in the distribution of dividend, it is necessary to bear in mind that there are some considerations acting rather in depreciation of the dividend. For instance, we shall propose to you to divide [illegible] the profit realised on the year as, with the provisional dividend paid on six months, amounts to 18 per cent. Last year we paid 17 per cent. the year before that 15 per cent., and in 1889 the first dividend paying year at all, we paid 10 per cent. Well, there is nothing so readily excited as the cupidity of mankind, and as our business is being watched with a great deal of interest by many outsiders who, when it becomes an open business, will be ready to launch upon it in competition with us, it is just as well to bear in mind that for the five years preceding those I have alluded to we paid no dividend at all, and perhaps it may [illegible] not our satisfaction, but the aspirations of some other people to know that, notwithstanding that we propose to pay this dividend to-day, really over the nine years the aggregate amount divided has only reached the moderate sum of 6¼ per cent. Now, as to the accounts themselves. I think I had better first take you through the working account. You will see it is very simple; it consists of only three or four headings. We begin every year, of course, with a large stock of lamps and material in anticipation of our requirements and manufacture on account of the current year, and the accounts of that carried forward from year to year are a matter of some importance in forming an opinion as to the position of the Company. It may be too large, or it may be too small. If it is too small the Company may be placed at a disadvantage in the event of a sudden growth in the demand, or if it is too large it will involve the locking up of more than a necessary amount of capital invested in the stock. Well, you see that on July 1, 1891, we brought into the accounts £59,308 worth of stock. That was made up largely of lamps, and of platinum and other material in hand. During the year, to keep abreast of the consumption and ensure the possession of a large stock, we have spent in wages, purchases of materials, etc., £59,000; that is the bare cost of the lamps produced at the factory—the mere mechanical part of producing and material worked up in the production of so many lamps. Then came the whole of the administration expenses, various heads of departments, directors, and all that machinery which represents in a public company what the brains and directing influence of a partner or partners, represent in an ordinary firm. Then there is a [illegible] amount, but quite sufficient, put down for depreciation of plant. On the other side of the account there are by sale of lamps, fittings, royalty on holders, etc., £166,348; interest, etc., [illegible] and the stock on hand when we emerged from the year, [illegible]. Of course, the difference between these two is the balance of profit to be dealt with for the year, which amounts to the respectable sum of £74,810. Now, what I want to call your attention to is that this account is satisfactory in the sense of our having considerably diminished the amount of money locked up in stock; and I think I may say that [illegible] without at all fearing questions upon the other possibility that there is not stock enough on hand to meet any sudden emergency. I think we may say to that extent our position is a little more wholesome than it was 12 months ago. The large figure of £166,348 is not made up exclusively of the sale of lamps, because

for the last two or three years we have ourselves been manufacturing fittings which are the adjuncts to lamps. We were driven into the necessity of making the fittings, first of all, because the holder of the lamp was a very delicate instrument and we found we could do it better than anybody else; so we acquired some very interesting and ingenious patents for fittings, and we are manufacturers, and also licensors. People who were gasfitters have become electric light fitters, and we give them the opportunity of manufacturing their own fittings if they choose, and they do that on the basis of royalty. From royalties paid by these licensees we receive a considerable annual sum, the advantage of that being that, whereas the lamp patents will expire at no very remote date, the patents for these fittings will run over a good many years, and afford us, for what I may call the protected period, a very considerable and growing annual profit. Respecting the balance, we have already distributed in the course of the year a considerable portion of it in the nature of a dividend, and we propose to apportion the remainder so as to produce this 18 per cent. upon the year; and, in order that you may understand that, I would refer you to paragraph 2 of the report, which is somewhat long and complicated. You will see it only repeats what I have told you—that the dividend of a particular year being limited to 7 per cent., all the rest of the profit goes in aid of those years during which no dividend was paid, because the 7 per cent., according to the contract between the partners, was to be cumulative. In addition to the capital upon which this is divided, we have, as you know, £117,000 of deferred shares, representing the proportion which Mr. Edison and his friends hold of the capital of this business—the consideration, in fact, for his patents, and so forth. Well, he has never received anything at present, nor can he or they who hold the shares receive anything until the A shareholders have received 7 per cent., not only in respect of the current year, but in respect of all past years. You will see in the paragraph to which I am referring that we have wiped out everything up to June 30, 1888. We still have on that account a considerable sum to meet out of future profits before the deferred shares get anything. Now, by the statement in the balance sheet showing the proposed appropriation of profits, you will see that the profit brought down from the working account is £74,810. 16s. 7d. The dividend for the year ended June 30, 1892, at 7 per cent. per annum, comes to £24,743. 9s. 2d., the payment of cumulative preferential dividend on the A shares for the year ended June 30, 1887—one of the years for which we paid nothing—at the rate of 7 per cent., to £24,743. 9s. 2d., and the payment on account of cumulative preferential dividend on the A shares for the year ended June 30, 1888, at the rate of 4 per cent., to £14,139. 2s. 4d. That comes altogether to £63,626. 0s. 8d., and that is the amount which we propose to distribute out of the £74,810; the balance we propose to carry to the revenue fund. That, of course, requires your confirmation, and we shall submit at the right moment a resolution authorising that application of the balance, which we hope you will approve. I think I had better come to the general paragraphs of the report, which, as a matter of fact, I think I have already exhausted. The third and fourth paragraphs say: "The Directors are glad to say that their electrical fittings business is prospering. The amount received as royalty from those who hold licenses for manufacturing holders and sockets for incandescent lamps is satisfactory, and is likely to increase year by year." I have gone through the same story in rather more words in what I have told you about why we entered upon manufacturing, and that this is a growing asset, and one having the great advantage of being protected by patents for a good number of years. Now I come to paragraph 5, which in very brief words records what in the earlier days of the Company would have been a positive calamity to us, and, even in these days, when we have felt our footing, and got this business upon something like a sound basis, is still a very serious loss, and that is the death of our old friend Mr. Leyland, which was almost awful in its suddenness. This loss created a vacancy, and we thought that, looking at the position which Major Flood Page had held in the Company for a good many years, and that he, like some of the rest of us, was not getting younger as time went on, he might very properly be relieved of some of the harrassing details of the business which it had been his lot to attend to as secretary, and put upon the Board in place of Mr. Leyland. Accordingly, we elected him as deputy chairman, and I hope you will confirm the judgment of the step we have taken. As to the balance sheet, the figures, in so far as the capital is concerned, are exactly where they were in the previous accounts—we have not increased the capital. Then there are sundry credit balances which show that we owe £16,493, and against that item may be set debtors on the other side, which amount to £30,800, and, as these are all good, you can see that we are all right there. Next we come to the balance brought from the profit and loss account, £74,810. 16s. 7d., from which is deducted interim dividend at the rate of 5s. 3d. per share on the A shares, £3 paid, 8s. 9d. per share on the fully-paid shares allotted to the Edison Electric Light Company, Limited, and 7s. 8d. per share on the fully paid shares allotted to the Swan United Electric Light Company, Limited, paid on February 22, 1892, amounting together to £30,271. 15s. 11d., and leaving a balance of £44,539. 0s. 8d. On the other side of the account is the old item brought forward year after year, showing where the money has gone to. This £234,638 represents the costs of patents, goodwill, preliminary outlay, loss on working, etc., as against £375,000 of A capital. Then come the assets. Firstly, £12,000 in the Manchester Edison-Swan Company, Limited, which pays no dividend at present. I do not know whether it is within the bounds of possibility that that company will pay a dividend on their deferred shares. If they do, that asset will be worth something; if not, it will not be worth much. Then come freehold property, £39,435, and plant and stock £67,328. With respect to the freehold property, we bought a considerable acreage of land at Ponder's End, with enormous buildings thereon, for the purpose of a factory. That land and the buildings were sold to us at a moment of great depression, and under circumstances which made the bargain for us exceedingly advantageous. The plant and stock represent the two items I have spoken of, lamps and so forth in hand, and the plant and machinery which we out of capital bought to make that factory a going concern. I suppose I may say that if we had to start afresh and find land in a position as advantageous, and put upon it buildings and plant as efficient as we have got now, it would cost a great deal more than these two sums represent, from which I draw the inference that as long as this business can be pursued we have a factory and land bought very economically, with a capacity for production which is very large, for a good number of years as a going concern, which will be of great value to this Company, and may be regarded as a very sound asset. Office furniture is put at the moderate figure of £173. 7s. 8d. We have written down from year to year nearly the capital value of the few luxuries we possess in the office. Debtors I have told you about; our investment in consols at cost stands at £20,000, and the cash at bankers and in hand is £30,719. That is the state of our accounts, which are very simple; and now, subject to answering any questions, I will move "That the report and accounts for the year ended June 30th, 1892, be received and adopted."

Major Flood Page seconded the motion.

Mr. Lorraine said the whole history of inventions showed that a patentee made more profit after his patent rights expired than while they lasted. The reason was that, although a hundred competitors might come forward, a hundred men thus advertised his goods, and he had established his market for their sale. The fear in regard to this Company seemed to be that as soon as their patents expired their profits were going to disappear; but he was strongly of opinion that that was not going to be the case. Electric engineers told him that, for some years at any rate, they will be afraid to specify any lamp but the Edison and Swan, because that was the one they actually knew. Another argument was that they were going to have lamps introduced from other countries, where labour was very cheap; but he believed that even in that event they would avoid a loss, inasmuch as their relations with the Swan Electric Company were such as to make it merely gaining money from one pocket which they lost from another. Mr. Lorraine also referred to the Company's getting part of their goods manufactured in Germany.

In reply, the **Chairman** expressed a belief that after the expiration of their patent rights in the lamp, there would be such an expansion of the business that the profit derivable from the lamp would remain in the hands of those who had the best trade-mark and the best hold upon the business—advantages which their Company had been aiming at securing. If they found hereafter that lamps could be produced at 2d. or 3d. each cheaper than in London, owing to the cost of labour, they were in a position to get them at their own factory in Germany, for the Swan United Company would be delighted to take an order from this Company to deliver lamps in London. If the London Trades Council became much more powerful the rate of wages, instead of being fixed by the master, would be decided by somebody else. Although in Germany there was a great deal of talk about Socialism, it was not so much practised there as in this country, and if the Company had much difficulty with their workmen in the future, they might be able to get their lamps made more cheaply in Germany. That showed the propriety of putting their two coaches—the English and the German—together.

The motion was then unanimously agreed to, and the resolution declaring the dividends was also carried.

The retiring Directors and auditors were re-elected, and the proceedings closed with a vote of thanks to the Chairman.

NATIONAL TELEPHONE COMPANY.

The annual general meeting of the National Telephone Company, Limited, was held on the 14th inst. at Cannon-street Hotel, E.C., Mr. James Staat Forbes (the chairman) presiding.

The **Secretary** (Mr. Albert Anns) read the notice convening the meeting.

The **Chairman** commenced his observations by sympathetically alluding to the loss the Company had sustained by the almost tragic death of their late president, Mr. Leyland. Literally (the Chairman said) Mr. Leyland died in harness, and almost his last words and thoughts were of the affairs of the Company. He went straight from the office, where he laboured ungrudgingly, and in 10 minutes he was gone. Some of them had the melancholy duty to perform of attending his funeral, and they came away bringing with them the impression, which could never be effaced, of the ability, experience, and devotion he had displayed during very troublesome times, and under very great responsibilities. Referring to the report, he proceeded to say that it was not so bad as it looked. The essence of it was in the first three paragraphs, which showed what they had earned, what it cost to earn it, what there was left, and what they proposed to do with it. The income accrued in respect of the business of the year amounted to £463,741, which was £32,000 more than in the corresponding half-year. Their business was a peculiar and, in some sense, an interesting one. Their subscribers paid in advance, and they also paid for intervals of time not limited by a particular year. A man might become a subscriber on January 1, but the financial year ended on April 30, and, therefore, although they took the subscriptions in advance

for 12 months, obviously only a portion of that subscription could be attributed to the business year. Consequently, there was an income of an accumulative kind, and there was an income for which the service had been given in return, which made the actual income of the year. In the first column of the abstract of accounts at the foot of the report, they gave the accrued income of the business of the year. The rentals or subscriptions which had been received in advance amounted in the aggregate to £234,000, which had been carried forward to the next year. The shareholders would be able to gather from the abstract of accounts what progress had been made from year to year, the net result, and the dividends. They would see that, concurrently with the increase in the income of the year, they had had a considerable increase in expenditure, and that the net revenue had become chargeable in respect of that increase with the considerable sum of £38,000. The increase of £32,628 upon so large a figure as £431,000 did not seem too brilliant. It was, in fact, only 7 per cent. of the whole; but there were one or two things which had to be considered. They had referred in paragraph 3 of the report to the fact that, in anticipation of certain things, such as the expiration of the patents, they deemed the time had arrived to relieve the subscribers of some portion of the rentals. The year under review was the first complete year in which those reductions came into operation. If the same number of subscribers that existed at the beginning of the year had paid the old rate during the whole of the last year, they would have added £55,000 more to the income. Of course, that was only in respect of the number of subscribers who were on their books at the beginning of the year ended April 30 last. In the interim, of course, they had obtained a considerable number of new subscribers, but he was not estimating anything in respect of the new subscribers, who all came on at the new rate. But a cession of £55,000 to their subscribers was, of course, a serious matter. They might have retained the old subscribers at the old rate; but probably they would not have extended their business, and might not have made that advance in the public confidence which they had done. However, they were pretty sure to have retained a larger income, although it was a wise thing to accede to the reduction. It must be borne in mind, in judging the progress of the year from that point of view, that that large sum of money had been returned, so to speak, to the pockets of the subscribers; and as a good many of them were under contracts for succeeding years, it was a very substantial gift for them. Well, there were some other things to be considered, in virtue of their patents. Up to the time of their expiration they were entitled to receive from subsidiary companies a royalty. On the item of royalty there had been a loss of £5,000. Besides that, they sold a number of instruments, and when they were patented instruments they got a bigger price; but now they were open they got less. By that they had made a loss of £1,000. There was another item which also showed a loss, and that was the balance brought forward. In the preceding year it was £11,000; but in the year that they were dealing with it was only £5,000, and therefore there was a diminution of £6,000. On that score, therefore, no less a sum than £65,500 was to be accounted for in the three ways he had referred to. They had some advantages. They were shareholders in one or more subsidiary companies, and the dividends from them in the year under review exceeded by £1,100 the dividends from the same source in the preceding year, and they were also fortunate enough to have more cash at their bankers' from time to time, and their interest account benefitted by about £1,000. He estimated that if they had not reduced the rentals, £65,000 would have been added to the increase of income. With regard to the working expenses, they had increased by £36,768; therefore the expenses had increased and the receipts diminished. Why had those expenses increased in that ratio? First of all, their income, notwithstanding the drawbacks he had mentioned, increased £32,628, then the number of new subscribers had increased. When they compared the increase in the number of subscribers with the increase of expenses they would find that the increase in the former was 20 per cent. and the increase in the latter 18 per cent.; therefore the expenses had only kept pace with the increase in the number of subscribers, and scarcely that. There was another thing which told against them: they paid royalties upon the gross income, and not the net, and, therefore, all the reductions which were called for by the public came out of that profit. They had, therefore, a less net income than they had last year. Out of the divisible balance, after providing for interest on debenture stock, an interim dividend of 6 per cent. per annum for the first half year had already been paid on the first and second preference shares, and 5 per cent. per annum on the ordinary shares. The Board would recommend the payment of a further dividend for the last half year at the rate of 6 per cent. per annum on the first and second preferences and 7 per cent. on the ordinary shares, making 6 per cent. for the year. The dividends, therefore, remained the same, but the balance carried forward had diminished. The Board proposed to transfer to the reserve account £10,000, which, with £1,127 placed to reserve during the year from premium account, would bring up the amount of the reserve to £104,627. There were two methods of getting a profit, one was looking forward and the other sticking fast, which encouraged dissatisfaction and competition about charges, which the public believed were immoderate. They had emerged from protection and were in the more healthy atmosphere of free trade, and they had to take care not only that their service was made as effective as skill and money could make it, but that the charge for the service was so moderate in relation to its value that customers should not be tempted by competitors who were always ready to bid for business at ruinous rates. What they had done was to prevent the possibility of competition, and the result appeared to them to be not only highly satisfactory as regarded the particular year, but very encouraging as regarded the future, because 20 per cent. increase in the number of subscribers was not an inconsiderable increase. That really was the essence of the whole of the accounts. Referring to the capital account, he said they would see that £320,991 had been expended during the year on construction of exchange trunk and private lines. A proper analysis of all their accounts depended upon a factor. Their business was, however, such a changeable one that it was a difficult matter to determine upon a factor. The Directors had exercised their brains a good deal upon the question of the factor by which to measure the value of the service, and they had taken the lines for that purpose, because to take the subscribers would not do. The number of lines during the year had increased by 20 per cent., while the expenses had increased by 18 per cent., charging the lines with the cost of the trunks. The cost of the installation of those lines was £220,000. They could not meet those outgoings which were apart from revenue and maintenance, without raising money, and during the period they had raised a considerable sum. The calls upon the 6 per cent. preference stock had been paid up, and represented £30,000. They had issued a small balance of ordinary stock, amounting to £5,000, and they had increased the debenture debt by a considerable sum. Paragraph 8 of the report opened a very important question, and had thrown upon the Board a most serious responsibility. The Company were universal licensees – that was to say, they had the privilege within the whole United Kingdom of laying down lines, opening exchanges, fixing their own rates, and conducting their business in their own fashion. That was a policy initiated by a man who had considerable claims to statesmanship, namely, Mr. Fawcett, when he was Postmaster-General, in contrast with the earlier policy, which was to limit their licenses and powers. They had gone on for several years spending their money and incurring risks upon the faith of that contract. There was one blemish in the matter, and that was that it was a sufferance, without any legal status or powers. That had resulted in this state of things: that the telephone in England had not advanced in relative user or perfection at all in the same degree as in other countries, where the conditions were different. If they had legal powers to do all the things which must be done in order to make an efficient service, they would have done it long ago, but they were not in that position. For several sessions they had been knocking at the door of Parliament to ask them to let the Company do what the subscribers and public were complaining that they did not do: give an efficient service and extend their business, but the Post Office would not let them in. The Post Office bought a monopoly of telegraphs at a price which made them very comfortable, and the policy of the Post Office in respect to telephones, until lately, appeared to be to leave them to struggle as best they could in the prosecution of their business, but by no means to help them. He did not complain of the Post Office. They had a business purchased at an enormous price, at the risk of the taxpayer – not at the risk of the shareholder – and they were bound to protect their revenue. During last year the Post Office transmitted 66,000,000 telegrams, which cost the public something approaching 9d. each, whereas this Company transmitted 160,000,000 of communications, so to speak, at a price approximating to 1½d. each. The average number of words in those communications meant not 12 words, but 40 or 50. The Company brought a Bill in this session demanding Parliament's attention to the matter, and it brought the question to a head, with the result that the Government determined upon a policy. The policy reversed, to some extent, the policy of Mr. Fawcett; that was to say, the company or the licensee was to be entitled, in areas to be determined by the Government, to carry on the business of exchange, but could not break the bounds except through the Government instrumentality; therefore, a man living in London could not communicate outside a particular area without the Government consent. They knew what that present area was, but they did not know what it was going to be. The Treasury minute expounded the policy, which was very curious. This Company began this business, and had to take all the risks of its imperfections as a new discovery, and all the risks of applying it without legal powers. All this was to be wiped out, and they were to go back now to a limited area. Of course, they had got a very valuable connection in their trunk wires, which supplied the means of intercommunication, and the proposition was that they should surrender that intercommunication, and hand it over to the State. In virtue of that surrender they were to be left in the areas, and to have certain privileges for their subscribers. They might transmit messages by telephone to be forwarded by telegraph; they might call a Government messenger to deliver their telephone message. There were several matters, no doubt, of great convenience and of some value, but the Directors considered that that alone was not equivalent to very much. The surrender of their trunk lines deprived them of just those advantages which the Treasury minute declared to be a menace if left in the hands of a private company. The telegraph and the telephone might be made one to help the other, but the proposal of the Government was a half and half measure. It complicated a thing which might be made simple; it brought it under a dual control; it would not facilitate either promptitude or simplicity, and he was not sure that it would promote economy in telephony. The proper thing for the Government to do was to acquire the telephones, but they did not do that. The shareholders would, therefore, see what a delicate and difficult position they were in. They might now agree with the Post Office to surrender their present concession, which gave them unlimited power as far as they could exercise it, and they might accept limited powers; but they did, in fact, put themselves more or less into the hands of the Post Office. It was true that they need not

agree; but then the Post Office would say: "If you do not agree we will promote people who will agree, and we will afford them the means of trunk communication from one end of the kingdom to the other, and then their competition with you will be a very easy one." The position of the Company was seriously influenced by that consideration, and they had made up their minds that they ought to agree with the Post Office, because as the licensees of the Post Office their relations were so intimate and so dependent upon them in many ways that mere prudence and loyalty would involve their doing everything they could to make this policy succeed; but, of course, they wanted to know what the consideration was to be. The surrender of the trunk wires, which was a *sine quâ non*, meant some important considerations, and the equivalent offered in the Treasury minute would not satisfy them upon the theory of taking the mere cost of the trunk wires, and surrendering their future money-earning value. The whole thing depended upon the Company getting fair terms, and the Directors were now in negotiation with the Post Office. No agreement with the Post Office would be settled without being submitted to the shareholders, because he thought it would be unfair to throw upon the Directors so immense a responsibility as to determine the whole future of the Company upon an agreement, the result of which no man could absolutely and clearly predict. Dealing with the ninth paragraph of the report, he pointed out that Mr. George Franklin, of Sheffield, had been elected a director, and that Mr William E. L. Gaine had been appointed general manager. In conclusion, he moved: "That the report and accounts be received and adopted, and that dividends be paid for the half year ended April 30 last, at the rate of 6 per cent. per annum, less income tax, on the amounts paid up on the first and second preference shares, and at the rate of 7 per cent. per annum, less income tax, on the amounts paid up on the ordinary shares, making, with the interim dividend already paid on such shares, 6 per cent. for the year ended April 30 last."

Colonel R. Raynsford Jackson seconded the resolution, which, after some discussion, was put and carried unanimously.

The retiring Directors and Auditors were re-elected.

At the conclusion of the meeting, the **Chairman** stated that the Board proposed to issue, to the amount of £1,000,000, 5 per cent. preference stock, for the purpose of taking over the Western Counties and South Wales Telephone Company, and it was proposed to allocate the stock *pro rata* to the shareholders. He made that statement in order to ascertain the views of the shareholders on the question, and whether they were disposed to take over the stock.

Mr Faithfull Begg thought the proposal a very reasonable one.

A vote of thanks was then given to the Chairman and Board, and the proceedings terminated.

SHEFFIELD TELEPHONE EXCHANGE AND ELECTRIC LIGHT COMPANY, LIMITED.

The third ordinary general meeting of this Company was held on Monday, at Sheffield. The sum of £795 was added to the reserve fund, and a dividend at the rate of 5 per cent. per annum was declared upon the ordinary shares.

At a subsequent extraordinary general meeting it was decided to reconstruct the Company under the title of the Sheffield Electric Light and Power Company, Limited, having for its object the exploitation and development of the parliamentary powers recently granted to the Company for the electric lighting of a compulsory area in the centre of the town, and also the application of electricity to commercial requirements generally, and respecting which there is a largely increasing demand. The Directors propose to pay off all the preferential shareholders, with interest to date, and to reduce to some extent the capital of the Company, such course being rendered possible by the sale of the Company's telephone exchange.

MANCHESTER EDISON-SWAN COMPANY, LIMITED.

The annual meeting of this Company was held on Monday at the Victoria Hotel, Manchester, Mr. V. K. Armitage, chairman of the Company, presiding.

In the Directors annual report, which was submitted, it was stated that the net profit for the year, including last year's balance, amounted to £2,826 1s 10d. Out of this it was proposed to pay a dividend at the rate of 5 per cent. per annum, which will absorb £1,000 to carry £1,000 to reserve fund, and to carry forward a balance of £826 1s 10d.

On the motion of the **Chairman**, seconded by **Mr W P James Fawcus**, the report was adopted, and the dividend recommended therein was declared payable.

Mr Armitage was re-elected a director of the Company, and thanks were accorded to the Directors for their services.

ELECTRICAL POWER STORAGE COMPANY.

The third ordinary general meeting of the Electrical Power Storage Company, Limited, was held on Wednesday, at 4, Great Winchester-street, E.C.

Mr J. I. Courtenay, in moving the adoption of the report, said that the dividend of 6 per cent. had been earned by the secondary battery manufacturing business at Millwall during the 12 months that had elapsed since the Company took it over from the Electric Construction Corporation. A gratifying increase of business had taken place in that time, and the financial position of the Company was a strong one, there being a balance of nearly £10,000 at the bankers, and current accounts due to the Company of upwards of £11,000, as against about half that sum owing by the Company. The only gold medal presented at the Electrical Exhibition for secondary batteries was awarded to the Company, and was proof of the excellence of their products. A further development of the foreign business, which had been hindered by competitors, was now anticipated.

Sir Daniel Cooper seconded the motion, which was carried.

The retiring Directors and Auditors were re-elected.

COMPANIES' REPORTS.

EASTERN TELEGRAPH COMPANY.

Report of the Directors for the half-year ended March 31, 1892, to be presented to the fortieth half yearly ordinary general meeting, to be held at Winchester House, 50, Old Broad-street, London, to-day.

The Directors submit the accounts and balance-sheet for the six months ended March 31, 1892. The revenue for the period amounted to £382,207 11s. 4d., from which are deducted £105,820 13s. for the ordinary expenses, and £53,515 5s 1d. for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing £2,979 17s. 6d. for income tax, there remains a balance of £219,900 15s. 9d., to which is added £57,509 7s 1d., brought from the preceding half year, making a total available balance of £277,410. 2s. 10d. From this amount there have been paid.

	£	s.
Interest on debentures and debenture stock	28,274	13
Dividend on preference shares .	20,474	2
An interim dividend of 1¼ per cent. on the ordinary shares	50,000	0
	£98,748	15

Leaving a balance of £178,661. 7s. 7d., from which £68,000 has been carried to general reserve. The Directors now recommend the declaration of a final dividend for the year ended 31st March, 1892, of 2s. 6d. per share and a bonus of 3s. per share, amounting together to £110,000, both payable on the 22nd instant, free of income tax, and making, with the three previous payments on account, a total distribution of 13s. per share, or 6½ per cent. for the year on the ordinary shares. The balance of £661 7s. 7d. shown at the foot of the revenue account is proposed to be carried forward to the next half year. The revenue includes £32,791 12s. dividends and bonus for the half year upon the Company's investments in the Eastern and South African, the Black Sea, the Direct Spanish, and the African Direct Telegraph Companies. The shareholders having at the last general meeting approved the principle of establishing a staff pension fund, your Directors have had the details worked out by experienced actuaries, and a scheme will be submitted to the meeting for dealing with the matter, together with a formal resolution empowering the Directors to carry out the necessary arrangements.

NEW COMPANIES REGISTERED.

Electrical Company, Limited.—Registered by Michael Abrahams, Sons and Co., 8, Old Jewry, E.C., with a capital of £15,000 in £5 shares. Object: to acquire the undertaking of Keys' Electric Company, Limited, in accordance with an agreement expressed to be made between that company of the one part and this Company of the other part, and to carry on and extend the same in all its branches. There shall not be less than two nor more than five Directors. The first are Messrs. Franz and Felix Deutsch. Qualification not specified. Remuneration, 10 per cent. of the net profits available for dividend.

J. C. Howell, Limited.—Registered by Deacon and Co., 4, St. Mary axe, with a capital of £25,000 in £5 shares. Object: to acquire the business as electrical engineer now carried on at New Dock, Llanelly, and 24, Queen Victoria-street, E.C., by J. C. Howell, and to develop and extend the same. There shall not be less than three nor more than seven Directors. The first are J. C. Howell and W. M. Meredith. Qualification not specified. Remuneration, J. C. Howell, £800, W. M. Meredith, £300, to be raised £50 per annum up to £800.

Theatre Electrical and Specialities Production Company, Limited.—Registered by Heald and Sons, 28A, Leicester square, W.C., with a capital of £5,000 in £1 shares. Object: to acquire the business of Messrs. Gretton, Madgen, and Heald, of 28A, Leicester square, and to carry on the business of caterers for public amusements in all its branches. Table A applies.

Leroni and Bowman, Limited.—Registered by Fraser and Christian, 4, Finsbury-circus, E.C., with a capital of £2,500 in £1 shares. Object: to carry into effect two agreements expressed to be made between V. G. Leroni and J. J. Bowman, and between T. W. and A. J. Hollington, of the first part, and this Company of the other part, for the acquisition of the undertaking of electrical engineers now carried on by V. G. Leroni and J. J. Bowman at Bow, and to develop and extend the same. There shall not be less

than three nor more than five Directors The first are A. J. and T. W. Hollington, V. G. Leconi, and J. J. Bowman. Qualification, £50. Remuneration not specified.

BUSINESS NOTES.

Electric Alphabetic Signals. -A syndicate has been formed to work Mr Kelway's electric signals.

Western and Brazilian Telegraph Company The receipts for the week ended July 15 were £2,559.

West India and Panama Telegraph Company. -The receipts for the half month ended July 15 were £2,091, against £1 973.

India Rubber, Gutta Percha, and Telegraph Works. An interim dividend of 10s. per share has been declared by the Directors.

St. James's and Pall Mall Electric Light Company -The Directors announce a half yearly interim distribution at the rate of 5 per cent per annum.

City and South London Railway -The receipts for the week ending July 17 were £766, against £689 for the same period of last year, or an increase of £77

Direct United States Cable Company.-The Directors of this Company recommend a final dividend of 3s 6d. per share, tax free, payable on and after 30th inst , making, with the interim dividends already paid, 3½ per cent. for the year ended June 30, carrying forward £3,730.

Electric Contractors Messrs. Evans, Stewart, Palmer, and Co. have taken premises at 47, Carnaby street, opposite the St James's and Pall Mall Company's new station, as electric light engineers and contractors. They have already carried out several business installations in the West end.

London-Paris Telephone A call office has been opened, in connection with the London Paris telephone, at the West Strand Telegraph Office, Charing Cross The office will be open day and night, and the charge for telephonic communication with Paris is 8s. for a conversation of three minutes

Anglo-American Telegraph Company —The Directors of this Company have declared an interim dividend for the quarter ended June 30 of 12s 6d. per cent. on the ordinary stock, and 25s. per cent. on the preferred stock, less income tax, payable on July 30 to the stockholders registered on the books on July 11, 1892.

Crompton and Co. —The report of Crompton and Co., Limited, for the year ending 31st March last, states that the net profits amount to £15,068 The Directors propose dividends of 3s. 6d per share on the preference shares, and 1s. 6d. per share on the ordinary shares, both for the half year: they also propose placing £1,000 to the reserve fund.

Globe Telegraph and Trust.—The report of the Directors for the year ended July 18 shows that the net revenue of the Company, after deduction of expenses, amounts to £192,243, and makes, with the balance of £1 876 brought forward, a total of £194,120. From this amount there has been distributed the sum of £133,057 in interim dividends, leaving an available balance of £61,061. The Directors recommend the payment of a final dividend for the year of 3s per share on the preference shares and 3s 9d per share on the ordinary shares, making, with the former distributions, a total dividend for the year of 6 per cent , less income tax, upon the preference and 1½ per cent. net (against 5½ per cent. for the preceding year upon the ordinary shares, and carrying forward a balance of £938.

Elmore's French Patent Copper Depositing Company. -The Directors invite applications for an issue of 20,500 perpetual 10 per cent preference shares of £2 each, entitled in addition to 5 per cent. (making 15 per cent.) out of the surplus profits after the ordinary shares have received 15 per cent. The 10 per cent interest is guaranteed for the first year by Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited. The shares, with the 13,250 already allotted and the 26,250 reserved for paying off existing debentures, will complete the 60,000 shares authorised by the shareholders at the general meeting. The report of M. Secretan, the general manager, presented to that meeting, showed that the estimated revenue which would be available for the payment of the 10 per cent. minimum dividend on the 100,000 preference shares (of which the shares now offered for subscription form part) was £114,240 per annum when the entire plant is erected, the annual amount required for the 10 per cent. dividend is only £20,000 per annum. To pay the further 5 per cent. after the ordinary shares have received 15 per cent. would require only £10,000, whereas, according to a calculation contained in the prospectus, £64,240 would remain available for that purpose The ordinary share capital of the Company is £200,000, divided into 100,000 shares of £2 each, all allotted.

PROVISIONAL PATENTS, 1892.

JULY 11.

12691. **Improvements in electromagnetic apparatus for controlling electric light and power circuits.** Sydney Ferris Walker, 195, Severn road, Cardiff.

12700. **A new or improved apparatus for carrying or conveying telegraph or telephone wires over houses or buildings** David William Peaks, 30, Newland, Northampton.

12731. **Improvements in electrolytic extraction of zinc** Siemens Bros. and Co., Limited, 28, Southampton buildings, Chancery lane, London. (Messrs. Siemens and Halske, Germany.)

12735. **Improvements in supports for telegraph insulators** John Crisp Fuller and George Fuller, 33, Chancery lane, London.

12737. **Improvements in electrical switches and incandescent lampholders.** Thomas Jenner and George Beckwell Wilkes, 77, Chancery lane, London.

JULY 12.

12745. **Electric signalling apparatus** Herbert John Allison, 52, Chancery lane, London (The Standard Electric Signal Company, United States.) (Complete specification

12759. **Improvements in or relating to electric railways especially those in which underground conduits are used, and in rolling-stock for the same** William Phillips Thompson, 6, Lord street Liverpool (Arthur B Hieatzman and Harry D Hieatzman United States.

12807. **Improvements in apparatus for regulating the arc in electric arc lamps** Alfred William Money and Herbert Nase, 23, Southampton buildings, Chancery lane, London

12818. **Improvements in conduits for electric railways** Edward Evans-Jackson, 45 Holborn viaduct, London (Charles Dibbie Comstock Huestis, United States.) (Complete specification.)

JULY 13.

12888. **Improvements in electrical regulating devices for clocks** Ludwig von Orth and Emil Breslauer, 323, High Holborn, London. (Complete specification.)

JULY 14

12906. **Improvements in and relating to "roses" or electrical connections for the ceilings of buildings or structures** William Martin Haddow and John Smith Hutcheson, 8, Buchanan street, Glasgow.

JULY 15.

12977. **Improvements in the electrolytic production of caustic soda or caustic potash.** Charles Anthony Burgess, Fountain street, Manchester.

12999. **Improvements in the method of and means for distributing electric currents.** Gisbert Kapp, 70, New street, Manchester.

JULY 16.

13072 **Improvements in coupling and fixing glass tubes for containing electric wires** Dan Rylands and Sidney Nash, Shepcote, Barnsley.

13090. **Improvements in portable electric lamps and also fuses for same** Killingworth William Hedges, 8, Queen's court, Chancery lane, London

13095. **Improvements relating to the electric heating of pottery and other furnaces and materials therefor** [illegible] von Poschinger, 18, Buckingham street, Strand, London.

SPECIFICATIONS PUBLISHED

1881.

4428 **Telephonic apparatus** Bennett. (Second edition.)

1890.

9125 **Telephonic apparatus.** Kingsbury (Western Electric Company). (Second edition.)

1891

12416. **Telephonic receivers.** Marr.

12585. **Electric switches** Newton. (Swan.)

14083. **Telephonic transmitters** Marr.

1892

9380 **Converting electric currents** Burton.

9541. **Electric accumulator.** Schmalhaus

9863. **Electric signalling apparatus** Lake (The Electric Secret Service Company).

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	[illegible]
Brush Co.	—	[illegible]
— Pref.	—	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
House to House	5	[illegible]
Metropolitan Electric Supply	—	[illegible]
London Electric Supply	5	[illegible]
Swan United	3¾	[illegible]
St. James'	—	[illegible]
National Telephone	5	[illegible]
Electric Construction	10	[illegible]
Westminster Electric	—	[illegible]
Liverpool Electric Supply	5	[illegible]
	5	[illegible]

Hanley.—At the monthly meeting of the Hanley Town Council last week, the borough surveyor was instructed to prepare a report on those tenders for electric lighting which utilise a site on the canal side for the central generating station, and to obtain from the different firms tendering for the street arc lighting in the above class such explanations and prices as would enable them to be placed on an equal footing.

Holbeach.—At a special meeting of the Holbeach (Lincolnshire) Local Board last week, the question of street lighting was considered. The tender for gas lighting was 40 and for electric lighting 80 per cent. more than oil. The tender for oil-lamps was accepted, though the inhabitants had petitioned in favour of gas. The streets used to be lighted by gas until a dispute arose with the gas company in consequence of the high charges made.

Motors.—Mr. Keeley is out of it. Another comprehensive inventor, Mr. S. H. Woods, of Minneapolis, has, we are told, arisen: he has invented a motor that is "cheaper than steam, electricity, or any other power at present in use." Of course the invention is (as yet) secret, but investors are invited to send up their dollars at once. Energy is to be taken from the blue sky by Mr. Woods, and mills, elevators, cars, and railways are to be driven!

Cardiff and Swansea.—The *South Wales News* complains that nothing yet is being done in the principal towns of South Wales to introduce the electric light. It suggests public spirited policy by the local authorities, and the consultation of Prof. Kennedy or Prof. Hopkinson, or other consulting engineers unconnected with any particular system, upon whose recommendation it is time to take action. "We have waited," says the *News*, "already too long for the adoption of electricity in South Wales.

Cork.—Said the chairman of the Standing Committee of the Cork Town Council last week: "The sooner we get electric light into the city the better for ourselves, and get rid of the gas company." Mr. Giltman said the gas company intended to ask the Corporation at the next meeting of the Council to consider their intention to ask the Board of Trade for authority to supply electrical energy. The chairman hoped every member of the Council would reject it, and that the Corporation would take over the lighting themselves.

Chicago.—The Westinghouse generators for the 93,000 16 c.p. lamps at the World's Fair are to be "the largest in the world." One of the dynamos will supply 20,000, and most of the others 10,000 each. Several Indian princes, with their retinues, have decided to visit the Chicago exhibition. Two of the original guns used on Columbus's flagship have been secured, and will be exhibited. It is hoped that the original apparatus fitted by Sir William Thomson at Valencia to transmit the first Atlantic cable message will be sent from England to the exhibition.

Electric Bullseye Lanterns.—A novel experiment has been tried this week, we learn, by the London police force in the substitution of small electric lamps for the ordinary oil bullseye lantern. The new venture has proved highly satisfactory. The electric lamp weighs 4lb., and is guaranteed to give a continuous light for seven hours. The tramway companies are also taking the matter up with much interest, with a view of permanently adopting electricity for lighting. Possibly the solution of train lighting will be rather by these storage lamps instead of the dynamo fittings on the train.

Lighthouse Communication.—The Royal Commission on electrical communication with lighthouses and lightships met again on Thursday last week, the Earl of Mount-Edgcumbe presiding. After considering the proposed methods of establishing communication by telegraph with lighthouses and lightships on the Scotch coast, the Commissioners arranged to go in the autumn on a tour of inspection. This will commence in the latter half of August at the Goodwin Sands and the mouth of the Thames. Visits will also be paid to Cromer, the Bristol Channel, and the Scilly Isles.

Crystal Palace.—The report of the directors of the Crystal Palace Company shows an increase last half-year of £5,735 in receipts, and £2,645 in expenditure, attributable to the electrical exhibition. It is a matter for regret that it did not prove more attractive. Notwithstanding the miles of cables and the high pressure in many cases employed, there has not been from first to last the smallest indication of fire. This may be attributed, we think, to the great care given by Mr. Heaphy to the arrangements. The extra £600 paid, it will be remembered, for insurance, was thus clear gain to the companies.

Eickemeyer-Field Motors.—M. Rudolf Eickemeyer was born in 1831 in Bavaria, being educated at the Polytechnic Institute of Darmstadt. He and Mr. Osterheld started a works in Yonkers before the Civil War, but he has since allied himself to Mr. Stephen D. Field, a nephew of Cyrus Field. The two have been very active in electrical inventions, Mr. Eickemeyer claiming early work in the alternating-motor field. He has other good things in store, but his latest success is the Yonkers electric railway, the cars being fitted with single gearless motors of [illegible] h.p., which run with great satisfaction.

Welding Rails.—The electric welding of street railway rails, as a substitute for fishplates, has been the subject of experiment in engineering shops in America for some time back. The process is said to be entirely successful. It is found possible to weld by electricity two pieces of steel of 25 square inches section, and therefore a solid rail four or five miles long can be produced if required. An interesting point to notice is that the tests are also said to prove that the necessity of joints to provide for contraction and expansion is not so apparent as engineers have supposed, though the data upon which such a result is based are not given.

Telephone v. Tramway.—The action between the National Telephone Company and the Leeds Electric Tramway Company (Mr. Graff Baker) has, we fancy, gone too far to be stopped by an impartial enquiry by the Chamber of Commerce. It is to be hoped that a good sound precedent will be established one way or the other. The question has gone through all the stages in America and on the Continent, where the Courts have decided that the streets being built for carriages to run upon, the tramways have the right to use the earth return if they desire, and so have the telephone companies—if they like to do so and find they can.

Chiswick.—The Chiswick Local Board obtained some time ago its provisional order under the Electric Lighting Acts. Absolutely ignorant of its value, they now propose to transfer their powers to Messrs. Bourne and Grant for £600 in cash. But that is not all. They propose to lease these gentlemen a magnificent site for a station for £1 per annum. Naturally, those of the inhabitants who know anything about electricity are much dissatisfied, and steps are being taken to memorialise the Board of Trade to refuse its sanction to the arrangement. The issue of the Chiswick Electric Lighting Company, Limited, is likely, therefore, to be postponed for the present.

The Tivoli Transmission.—A correspondent of one of the Italian papers gives an interesting account of

his recent visit to Tivoli, where the transmission of electricity from that town to Rome has now been inaugurated. In the transmission of the power the loss is very small, being reduced to 20 per cent. in all. With regard to the distribution of energy, it has been proved that at a small cost this can be increased so as to provide Rome with electric light, not only for public illumination, but also for public industries. The six turbines, the motive power of the work, represent 2,000 h.p., and are placed at the base of an enormous tower of masonry, which conceals the cascade, and which is supported by the ancient wall that surrounds the town.

Japan.—As one of the markets of the world, Japan offers many advantages. For one reason its inhabitants are determined to progress and to introduce all the latest developments of Western civilisation. The progress made in electrical matters is astonishing—the Tokio Electrical Society has, we are told, already over 12,000 members. There are now 1,014 telegraph offices, and Tokio numbers over 1,000 telephone subscribers. Tokio and Osaka are connected by a telephone line, 350 miles long. Two electric railways, 12 and 17 miles long respectively, are under contemplation. A Japan Society has recently been formed in London, and we notice that members of some electrical firms are joining—a wisdom of the serpent that commends itself from the point of view of "foreign markets."

Air Condenser.—An interesting departure is to be made in the Dundee central station, in the shape of the use of what is known as an air condenser instead of a water condenser. The exhaust steam is led along a series of pipes, the outsides of which are exposed to air, and further kept cool by water trickling down the sides. This arrangement must not be confused with the air cooler used at the St. Pancras installation, in which the hot water is cooled by exposure to the winds of heaven after having been condensed by the ordinary water-spray condenser. The engineers to the Dundee installation are Messrs. Urquhart and Small, Westminster, by whose advice the air condensers are being adopted. The contract for the pipes, we believe, has not yet been actually decided waiting this extension.

Electric Locomotives.—"It has yet to be proved," says the *Engineer* in an article on electric locomotives, "that it is possible to make an electric motor which will comply with all the multifarious conditions inexorably dictated by the exigencies of traffic. In the United States nothing of the sort has yet been produced, and it is fair to assume that they know as much at the other side of the Atlantic as is known at this about electricity. Apparently a very wide departure from existing methods and principles of construction may be needed to secure success, and no one can say that the field of invention in this direction is nearly filled. It seems, however, to be almost time that someone with the requisite knowledge and ingenuity set himself in earnest to the work of designing a real electrical locomotive."

Electric Dairy.—Mr. James Blyth, nephew of the famous breeder, Mr. Walter Gilbey, has gone in for extreme advance in his new dairy at Blythwood, where electricity is used as motive force. Mr. Blyth and his architect visited all the best dairies on the Continent and at home, and also took the best advice as to machinery and utensils. The result is a half-timbered Jacobean structure of red brick and oak, with a Carrara marble dairy in the basement. The building is fitted throughout with electric light, and all the motive power for separators and churns is supplied by electricity. The opening was performed on Saturday by the Lady Mayoress, in the presence of a very distinguished company, and doubtless marks the beginning of a considerable extension of scientific dairying in which the dainty goddess Electra, as in so many other fields, will play an important part.

Waterford.—So far the electric light is saved for Waterford. A motion was brought forward before the Electric Lighting Committee at the last meeting to the effect that the lighting should be handed over forthwith to the gas company. On the strenuous bringing forward by the Mayor and Alderman Ryan of the facts that the provisional order, which had cost £400, would be lost, and that the lighting by electricity now saved £1 a lamp—a total of another £400 a year—the motion was successfully resisted, but only by the casting vote of the Mayor. The Corporation have only just saved themselves from the imputation of unfairness and jobbery, and it is to be hoped that the question of public lighting of the principal streets will now be put on a proper basis, with the reversion of the plant to the municipality after the due number of years.

Electricity in Collieries.—The owners of the Ashington Colliery, for whom Messrs. Ernest Scott and Mountain, Limited, of the Close Works, Newcastle-on-Tyne, have recently supplied an installation consisting of one of their Tyne compound-wound dynamos, capable of running 100 16-c.p. incandescent lamps, together with lamps, etc., which has given every satisfaction, have decided to extend their installation, and have placed the contract for the extension, which consists of a 400 light dynamo with lamps and fittings, in the hands of the same firm. Messrs. Scott and Mountain have recently completed a large electric light installation for the Birtley Iron Company, comprising a vertical engine and Tyne compound-wound dynamo to run 200 16-c.p. lamps. We understand that Messrs. Ernest Scott and Mountain are making a speciality of electric pumping and transmission of power installations for colliery purposes. They have recently introduced several novelties, and are about to issue a new catalogue illustrating this kind of machinery.

Phonograph Dynamo.—Although the phonograph has been objected to for the alleged reason of its being a toy merely, and because the listener does not hear corrections until after the sentence has been given, yet we notice it seems to be coming into use in business offices in New York. Mr. Erasmus Winans considers it "even more valuable than the typewriter." It is used in the offices of our New York namesake, and is said to be "always reliable," even at 300 words a minute. We allude to this instrument because of the introduction of a new toy dynamo brought out by the Eastern Electric Light and Storage Battery Company, of Lowell, Mass., used to charge the two storage cells for driving the phonograph. These dynamos are small enough to be carried in a satchel, and can be run by a cord from any convenient engine or shaft that happens to be going, and give 15 amperes for charging. The cells take 150 ampere-hours, and a gelatine electrolyte cell is now being employed. Such a set of dynamo and cells might be useful for other purposes—such as mining inspectors' lamps.

Niagara Falls.—We see it stated that Prof. Unwin, of the City Guilds College, has been offered £5,000 a year to undertake the duties of engineer-in-chief to the Niagara Falls Company, who intend shortly to utilise and distribute half a million horse-power. The company seem to be determined to have the best advice obtainable. Lord Kelvin, Colonel Turettini (engineer to the Geneva works), Prof. Forbes, lately Mr. Edison, and now, if it be true, Prof. Unwin, have been invited to join forces with Nature at this problem. Mr. Tesla, also, is on his way back to the States to do his quota in the distribution problem, and Mr. Ferranti, we have all heard, has early had a hand in this stupenduous undertaking, which certainly has a fascination entirely its own to engineering minds.

The works at the Falls are progressing rapidly, over 100,000 bricks being laid per day towards completing the tunnel, 1½ miles long, which is to lead the water from above the Falls to the turbines at the rapids. Chicago may yet achieve her darling wish, and receive power by wire from Niagara.

Weybridge.—A public meeting was held by the inhabitants of Weybridge last week to meet Colonel Martindale and other directors of the Laing, Wharton, and Down Syndicate with reference to the electric lighting. Colonel Martindale explained that they had intended to go on quietly building up a business, but that the Board of Trade had insisted on certain things which necessitated heavier expenditure than they could undertake alone. They proposed to take payment for the present plant at cost actually expended—£7,000—in shares of a new company; to do the necessary work in putting wires underground for a further £7,500, half in cash and half in shares, the Weybridge Company also to pay £1,500 cash on account of registration and expenses of formation and cost of provisional order. It was ultimately resolved to ask the following gentlemen to act as a committee to meet the directors of the syndicate and discuss matters: Captains Hawes and Bax, and Messrs. Verity, Benson, Ward, Young, Vardy, Palmer, and Drs. Sealy and Powell.

High-Tension Accidents.—The recent reports of the recovery of patients struck by lightning after two, four, or eight hours' treatment for asphyxiation, have called the attention of medical men to this question. Dr. Lacassagne, of the Faculte de Medecine of Lyons, has issued a pamphlet, in which he prays all who have had to do with accidents to human life from high-tension currents to fill in full particulars to his circular of questions, the answers being treated as private when desired. The questions deal with part of body touched, potential, earth or short circuit, whether victim dropped or was pulled off, sensations, treatment adopted, whether burns, difficulty of walking, of breathing, of seeing, headache, sciatica, etc., as results; duration, effect on sleep, etc., dynamo or transformer current, and so forth. Copies of this circular can be obtained, and for the sake of the medical faculty, everyone who has seen or experienced such an accident should endeavour to fill in the particulars. Above all, they should remember that careful treatment for artificial respiration by movements of arms, hot flannels, jerking the tongue, should be persisted in for hours, and will probably result in the saving of life.

"Old America."—Such is the name of the attraction that rules at Manchester; in other words, an exhibition is now being held in the Botanical Gardens at Manchester at which a street to represent Old America plays a conspicuous part. More conspicuous still is the representation of the old Eddystone lighthouse, removed from the Naval Exhibition. The revolving beams from the lighthouse tower are eagerly watched in and around Manchester as they ever were in London. The grounds and buildings are electrically lighted, the work being in the hands of Messrs. Siemens. Two 300-h.p. units are used at night, a smaller plant being used in the daytime. The boilers are by Galloway; the engines are the well-known Willans central valve, and the dynamos and all the lighting appurtenances are by Messrs. Siemens. At a visit paid to the installation last Saturday, everything was found in apple-pie order. Messrs. Siemens have gained a great reputation for excellence of work, and when it is considered that the whole of this installation was completed within a couple of months of receiving the order, great credit must be given to those into whose hands the duty of putting up the installation was placed.

Electric Light in Colleges.—The electric light was turned on last week to the dining-hall in Magdalen College, in the presence of the president of the college, the vice-president, and Messrs. A. D. Godley, E. M. Miller, C. H. Turner, and C. C. J. Webb (Fellows), also Mr. A. Hassell and Mrs. Hassell (Christ Church). There were also present Mr. Selby-Bigge, director, and Mr. J. H. M. Lean, engineer to the Oxford Electric Company. The hall has been fitted with 76 lamps of 16 c.p. each fixed on brackets arranged round the hall, six lamps on each bracket. Two ornamental upright brackets are fixed on the gallery, with a cluster of a dozen lamps on each which have a very pretty effect. The effect was very brilliant, and the president and all the college authorities who were present expressed themselves highly satisfied. Brasenose and Hertford Colleges are being fitted with the electric light throughout, and both places will be completed in a few weeks. Brasenose will have lamps amounting to an equivalent of over 700 8-c.p. lamps, and Hertford an equivalent of 400. The Oxford Company are about to lay a considerably larger number of underground mains in different streets to cope with the demand which is arising for the light.

Coventry Tramways.—Mr. W. E. Graff Baker, who has purchased the undertaking of the Coventry and District Tramways Company, has made an important proposal to the Coventry City Council. Addressing that body as the principal local authority on the route of the tramways, which extend from Coventry railway station to Bedworth—a distance of about six miles—he proposes that it shall, with the concurrence of the other local authorities, purchase the entire tramway lines, and all the various parliamentary powers in connection therewith. He further proposes that the Council shall give him a lease of the lines for a period of 21 years, with liberty to assign with the Council's approval. The price to be paid to him is to be £12,000, Mr. Baker at his own cost to relay the paving on the line of route and the copper wire thereunder, which will be used in the operation of the road by electricity. Mr. Baker, under the lease, is to pay a rent of £840 per annum, payable in advance, which, by the end of the lease, will cover the amortisation of the principal—the cost being thus written off; the Council, however, to be responsible for the maintenance of the lines. Should the proposition meet with approval, Mr. Baker will at once put down the necessary plant and equipment for the operation of the tramways by electricity at regular and frequent intervals, and one of his banks is prepared to advance the sum of £12,000 necessary for the purchase of the tramways, should the Council require it, for 21 years at 3½ per cent.

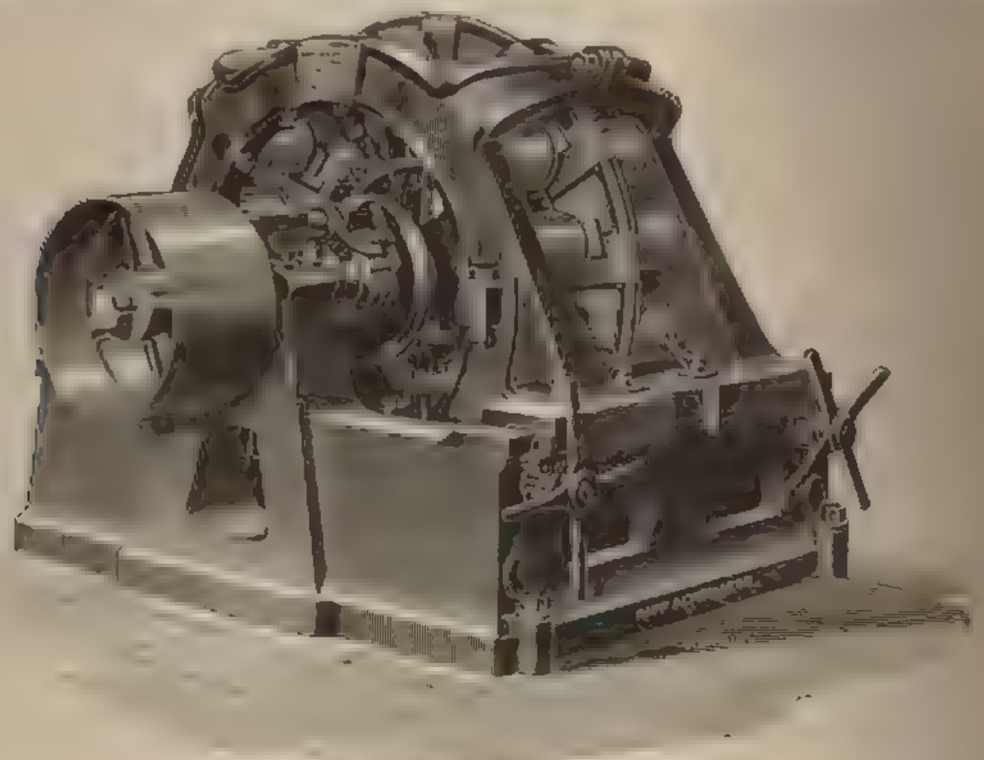
Dublin.—In the early hours of Wednesday morning the principal streets of Dublin were illuminated for the first time by the electric light. The run was made as a test, and was remarkably successful. The light was exceedingly bright and steady, and was a brilliant contrast to the dull and flickering gas jets which were still unextinguished. The appearance of the city under electric light was as if daylight had suddenly broken in upon the darkness before its time, and the officials of the Corporation and the contractors feel the greatest satisfaction in the result of the trial. "For more than an hour," says a correspondent, "the electric light reigned supreme, and it was a great pity that the trial should have taken place in the early hours, when the people were prevented from witnessing the effective working of the system. When the engines were stopped, and gas again shed the

ALTERNATE-CURRENT DYNAMOS.

BY R. W. WEEKES, WHIT.SCH.

Messrs. Johnson and Phillips.—The Kapp alternators made by this firm complete the list of those having moving armatures and fixed magnets. The arrangement of the field magnets is different from the two last described, as the opposite poles have in this case the same polarity. The magnetic lines of force pass from one magnet to the next on the same side of the machine through the iron core of the armature. So, though a set of poles is required on each side of the armature to give magnetic and mechanical balance, yet the magnetic lines generated by the set of poles on each side of the armature are distinct in their action.

The mechanical construction of the field is briefly as follows: The magnet cores are made of wrought iron, and inlet into cast-iron frames, as seen in the illustration. Cast-iron pole faces are screwed to the cores after the exciting coils have been placed in position. The pole face is made nearly rectangular, so that there shall be an equal number of lines of force entering the armature core at all distances from the centre. This is to prevent as much as possible the flow of lines from one lamination of the core to the next, which would produce eddy currents in the iron. The cast-iron frame into which the cores are fastened is made in two halves, and bolted together to facilitate the removal of the armature when needed. In the large machines, each ring of magnets is arranged to withdraw along the axis of the armature by means of a rack and pinion gear to enable the armature to be examined *in situ*. The armature core is built up by winding charcoal iron strip of the full width of the core on to a cast iron spider ring till the desired depth is obtained. The number of arms in the spider is half the number of poles in the machine, so that two coils are wound in each space between the arms. The outside of the core is then made up with hard wood to the desired contour where the coils have to be wound. The wood blocks all round are secured in position by driving bolts, and bound on by means of steel wire wound in the circumferential groove left for this purpose. The coils are direct driven by means of shoulders on the wood and the spider arms. The core is insulated with mica and two layers of vulcanised fibre when the conductor has to be wound, and the cast iron spider is fitted with ebonite caps where needed. In this machine the armature conductor has to be wound in place, and in case of damage a coil cannot be replaced, but has to be rewound. The makers claim that the construction of the armature is so strong and the insulation so well looked after that the armature coils do not get loose or burn out. In the small machine exhibited all the armature coils are connected in series, but in the larger central station alternators the two halves of the armature are connected in parallel to reduce the voltage between any two adjacent coils. The conductor used is circular wire in the smaller machines, but in the large 120 kilowatt alternator two thin strips, viz. by ·230in., are wound on edge and connected in parallel. The connections are made to bolts in the spider ring which are well insulated from the spider itself. The current is collected by ordinary copper brushes, of which there are



Johnson and Philips 120-K.W. Alternator

Johnson and Phillips 30-K.W. Alternator

two to each collecting ring. This ring has its collecting surface vertical, and not horizontal, as is the case in the other alternators. This is done to enable the collector to be placed well inside the magnet frame, so as to render the dangerous parts inaccessible to a casual passer by. The magnet poles are inlet into a sheet brass ring, so that

larger than that of the wrought iron, and the spaces so left at the ends are filled in with wood, which forms the insulating support for the armature coils. These coils are wound flat on wooden cores, and then laid on the inner surface of the wrought iron with a sheet of insulating material between. Another wooden ring at each end keeps the coils in position, and securely clamps both the wooden core and the conductors. This ring is made in segments, so that when it is necessary to take out a coil, one segment only need be displaced. On examining the machine when not at work it will be seen that the breadth of the wooden cores is about equal to twice the breadth of the winding. Thus on the armature surface the cores and the conductors occupy equal space alternately, as shown in Fig. 4. The connections between the armature coils are made in the channels cast in the frame (Fig. 3). There are spaces left in casting for the conductors to come through, and the joints are well protected by the lagging of wood. As the armature is fixed, the two ends, after all the coils are connected in series, are led to two terminals, which also are usually placed under the wood lagging. This ensures that no dangerous shock can be got from the machine, as the high tension parts are inaccessible. The insulation of the armature is well carried out, and should give no trouble. The hysteresis loss in the iron is likely to be higher than in the machine last described, as more iron is needed, but there will be very little fluctuation in the field as the armature iron circuit is uniform. The magnets are excited from a 100-volt circuit, and take 16 amperes; thus 5·3 per cent. of the total power given out is required to excite the field. This high value is due to the design and the small size of the machine, as the radial form of magnets does not allow much space for winding when the diameter is small. The mechanical details of this alternator are well designed and carried out, and should give little trouble.

The details of the 30-kilowatt alternator exhibited are as follows: Output, 1,000 volts, 30 amperes at 600 revolutions, 60 complete periods per second, weight complete, 2 tons 15cwt.; floor space, 4ft. 6in. by 4ft.; height, 4ft. 4in.; armature, 36in. diameter, 6in. active length; conductors, ·015 square inch section, wound in 12 coils of 34 turns each; 12 poles of wrought iron, 3in. by 6in.

UTILISATION OF WATER POWER.*

BY HERBERT G. COALES, A.M.I.C.E., ENGINEER AND SURVEYOR TO THE MARKET HARBOROUGH LOCAL BOARD.

It has occurred to the author many times that the utilisation of water power has not received the amount of attention at the hands of the association to which it is entitled—indeed, he can find no paper bearing upon the subject. By placing a few notes before you it is hoped that the recital of your experience and suggestions may be conducive to the further utilisation of water power in the service of our towns and districts. The author casts the responsibility of this paper upon the association, because no more experienced member has hitherto introduced the subject.

In using the term water power it must not be understood that of itself water has any power any more than a spindle has—but it is necessarily acted upon by the energy of gravity, and being practically incompressible, is capable of transmitting power. It is only in this sense, therefore, that the term is used. If municipal engineers would take the trouble to investigate the available amount of water power in their localities for the purposes of applying it for the benefit of their districts, probably not a little advantage might be gained in many directions. Members of this association who have already requisitioned water power for municipal engineering, would confer a great benefit on some of us by narrating the details and efficiency of such work. Our subject has practically nothing to do with the application of machinery to water, but that of water to machinery, except in so far as reference is made to hydraulic mains, having an artificial head caused by the pumping of water under a load into mains, which in turn are to be used for motive power. Doubtless a convenient course will be to classify the subject under three heads: I. Sources of energy. II. Water motors. III. Application of power.

I. Sources of Energy.

Water is a source of energy which, unlike that of coal, is unaffected by strikes; neither is it a power which is ever likely to be more limited than it is at present. Vapour having been raised by the sun's heat, clouds are formed at various distances from the earth's surface. The rain falling from these clouds provides a power which it is the privilege of man to utilise. The higher the elevation of water above the sea-level, the greater the source of energy obtainable. When we consider that falling water is capable, theoretically, of performing just the amount of work which would be required to raise it to the height from which it has fallen, we can understand what an enormous available power exists in nature for the working of machines. When water falls freely its descent will be accelerated in the same manner as that of falling solid bodies. It is, nevertheless, seldom that direct advantage can be obtained from this law, as most of the water falling upon the earth's surface sooner or later finds its way to channels and streams, the inclinations of which are flat and the beds rough, causing great friction. Wherever there is water there is power, and if we remind ourselves that about 3,000 tons of water fall on every acre of area in England per annum, we see that there is no insignificant power which it is our duty to press into the service of man. Evidently only a proportion of the water can be profitably employed as a motor, as the fallen rain has to serve other purposes in nature. But, on the other hand, water can be used over and over again, being unlike steam in this respect, which, on leaving the cylinder, is evaporated. Perpetual motion is a demonstrated impossibility, but in a constant supply of flowing water, as in some stream which is never dry, we approach very nearly to the long sought-for discovery.

It has occurred to the author that besides the power to be obtained from rivers, streams, waterfalls, lakes, tides, etc., small motors might more generally be driven from the water mains, sewage water, storm water, etc. In Market Harborough the pressure in the water mains is sufficient for working such machines as hydraulic lifts, there being a head of 200ft. This head is not sufficient for giving a proportionate efficiency as compared with steam for all purposes, but such a head might be utilised where the employment of other generating power would be out of the question. Mr. J. W. Sutcliffe, in the *Proceedings* of the Institution of Civil Engineers, says, "Every square mile of freely drained area of watershed in this district (East Lancashire and West Yorkshire) will furnish 0·2 h.p. per foot of fall (with very little storage), except during a few weeks in summer, when steam machinery is in its state of maximum efficiency." To take the greatest known source of water power in the world, we are told that the Falls of Niagara has a total descent of 334ft., and discharges about 40,000,000 tons of water per hour; giving a horse-power of over 15,000,000—a power which it is difficult to conceive. At Bellegarde, at the confluence of the Rhone and the Valserine, on a fall of 40ft., 3,700 h.p. are utilised by six turbines. With respect to tidal power, the result of opinion of a discussion at the Yorkshire College Engineering Society appears to have been that it had been somewhat over-estimated. The greatest possible advantage derived from each acre of water 10ft. deep, reckoning a working day at eight hours, was stated to be 3¾ h.p.

An example of unemployed water power may perhaps be here given. Eight years ago the author visited what was then, and is probably now, some disused machinery at St. Germains, in Norfolk. The works were constructed for the purpose of draining low-lying land a few miles from King's Lynn, which is, as you know, at the mouth of the River Ouse. A channel was cut from the Ouse for a distance of 11 miles south of King's Lynn, and at four miles from the town a huge dam was thrown across the channel for the purpose of preventing the tide from flooding the low-lying country on its south side. At low tide it became necessary to liberate the accumulated water on the south side. To this end a series of 16 syphons, 3ft. in diameter, were conveyed over the dam, and protected from the damaging effects of drifting ice and timber by a large

* Paper read at the annual meeting of the Incorporated Association of Municipal and County Engineers at Bury, July, 1892.

with other waterwheels. Gear for increasing the driven speeds with ordinary waterwheels is dispensed with. The first cost of turbines, except those for very low falls is less than for ordinary waterwheels, made in iron, of corresponding power. Where the fall of water is small they yield a better, but where it is great, a worse result than the other wheels. Where, however, the fall is more than 40ft., ordinary waterwheels cannot as a rule be conveniently used, while turbines can be used for falls of several hundred feet. Turbines are, therefore, best adapted for small and very great falls, and the ordinary waterwheels for moderate falls of water.

Jonval's low-pressure turbines are suitable for falls of 30ft. and under. They are either fixed in pentroughs, or inside a close case, according as the fall is great or small.

The effective horse-power of turbines = $\cdot079\,Q\,h$. Quantity of water in cube feet per second = $12\cdot6\,\frac{\text{H.P.}}{h}$.

The volume of many streams could be increased by leading smaller streams into the one channel, should an increased power beyond that existing be necessary. Under many conditions the water, after leaving the turbines and other motors, would flow on without in the least interfering with the existing rights of millowners and others.

Hydraulic Ram.

Hydraulic rams are used for the raising of water only, and are actuated by the weight of the water which they have to raise, or other source of energy—such as sewage water. The useful effect is nil when the lift reaches 26 times the fall, and no delivery can then be expected. The lifting capacity of hydraulic rams is very small comparatively, and as they do not provide motive power, municipal engineers can find little use for them. The effective horse-power of the ram = $\cdot00113\,Q\,h$. Quantity of water used in cube feet per minute = $\frac{881\text{ H.P.}}{h}$.

Water-Pressure Engine.

Water may be brought to act upon the piston of an engine in precisely the same way as steam acts in a steam engine, the pressure being according to the head of water utilised. There is a considerable loss of energy in the flow of water due to friction, consequently a water pressure engine must be run at a much less speed than a steam engine, the frictional losses of energy in a fluid being proportional to its weight. A steam engine has a piston speed of 400ft. or 500ft. per minute; a water-pressure engine rarely has a speed exceeding 60ft. per minute. It is just when an exceptionally high pressure can be obtained, or requires to be used, that the water-pressure engine is most applicable. One of the drawbacks of this type of engine is that the same amount of energy must be expended each stroke whether the load is heavy or light. These engines work with good efficiency when the fall and lift are constant, and when quite proportioned to the work to be done. The effective horse-power of a water-pressure engine = $\cdot00151\,Q\,h$. Quantity of water in cube feet per minute = $\frac{661\text{ H.P.}}{h}$.

Hydraulic Mains.

Bramah, in 1796, by an ingenious contrivance, first gave the principle of the hydrostatic press a practical application. He saw that the incompressibility of water formed a favourable medium for the transmission of force, and it was utilised by him by means of a small pump at a high pressure, acting with the least possible loss by friction on a large piston or ram, thus obviating the necessity of gearing. It was not, however, until 50 years after this that water pressure was utilised in other directions for power purposes. In 1846 Lord Armstrong erected the first hydraulic crane at Newcastle Quay, since which date numerous and valuable machines driven by water pressure have been invented. Lord Armstrong, Mr. Ellington, and Prof. H. Robinson were the first to inaugurate the laying of high-pressure water mains in towns for the purpose of providing power for the use of private consumers, without their having to separately erect the generating plant necessary for causing the required artificial head. The author here begs to acknowledge that much of the information contained in this paper is obtained from the experience of these gentlemen, and also from Prof. Unwin. Hydraulic mains have been laid in Hull, London, Birmingham, and other towns, side by side with gas and water pipes. The most economical pressure to use appears to be about 800lb. to the square inch, which is generated by steam engines pumping into the mains and accumulators.

The accumulator, which fulfils most important functions in connection with the mains, may be described as a cylinder in which a ram works, the top of which is weighted to the required pressure. This weight, which is raised as the piston ascends, of necessity gives the water an artificial head, equal to a column of water of great height. If, for instance, the pressure within the main is 800lb to the square inch, it is the equivalent of a column 1,848ft. high, which, for practical purposes, in most instances it would be almost impossible to obtain. Besides serving to produce an artificial head, the accumulator also stores up the water pumped when it is in excess of the water consumed, and, in fact, performs in the hydraulic system the functions of the flywheel of a steam engine. As the consumption of water by the machines connected with the main falls below the supply of water pumped by the engine, the ram rises and stores in the cylinder the excess, until the ram has risen to the top of its stroke, when it cuts off the steam from the engine by closing the throttle-valve. On the other hand, when the consumption of water by the machines is greater than is being supplied at the time by the engine, the ram falls and supplies the deficiency, at the same time opening the steam throttle-valve by which the full power of the engine is brought into operation. The accumulator thus acts as a reservoir of power and as a conservator of its distribution.

Prof. Unwin writes concerning the power to be obtained from hydraulic mains, "The pressure is too great to be conveniently applied in a turbine, and the pressure engine in its ordinary form is too extravagant in its consumption of water for ordinary power purposes."

Without going into the relative advantages of the various types of pressure engines, we may mention that the Hastie, the Brotherhood, and the Pelton are being used in London for power purposes. These machines have an efficiency of from 80 to 85 per cent. The Chester Hydraulic Engineering Company (who constructed the hydraulic machinery used by the London and Hull Hydraulic Power Companies) state that they have recently fixed in London, besides a large number of Brotherhood hydraulic engines, several Pelton motors. This is a high-speed motor and has a little greater efficiency than the Brotherhood. For slow driving or for machines which require to be frequently stopped and started the Brotherhood engine is the best, but for high-speed machinery, such as for driving dynamos, the Pelton is recommended as there is no necessity for intermediate gearing, and the full power of the motor is utilised.

Possibly, as motive power is not a necessity to people in the same sense as drinking water is, it will be some time before municipalities undertake the installation of power mains themselves, but that it may some day be the duty of municipal engineers to lay them down is not unlikely.

III. Application of Power.

In many directions there is undoubtedly a field for the utilisation of water power in conjunction with that of electricity. A great deal of water runs away year after year unused, to the sea, which might be the motive power for driving electromotors, and for producing electric light. Particularly is this the case in small towns and villages, which by the introduction of these facilities might find it possible to carry on many industries with greater advantage than at present. This would be a desideratum not to be despised, as it is now the object of statesmen, if possible, to prevent people from crowding into the larger towns, seeking the employment which to a considerable extent is dependent upon efficient machinery. As a body of men having at heart the physical welfare of the inhabitants of our towns, we should welcome the results foreshadowed here as a most desirable thing.

Some public authorities which are in the unfortunate

position of not owning the gas works, have frequent and reasonable cause for complaint with respect to both the efficiency and the price of the light supplied to the street lamps.

Where the conditions of the locality are favourable for the utilisation of water for driving dynamos for producing electric light, the public authority is possessed of a strong lever for the reduction of its gas bill, if it does not inaugurate electric lighting. A case in point occurred not long ago at Carlow. The municipal authorities quarrelled with the gas company and determined to discontinue gas lighting, and to start electric lighting instead. Carlow being situated at the junction of the rivers Barrow and Burren, plenty of water power was available. A disused corn-mill, five miles away from the town, was converted into a dynamo-room, the old waterwheel of the mill doing the necessary work. It is, however, intended to erect a turbine in the future. The wires conveying the current are carried overhead on poles to the town.

Efforts are being made in the Alpine countries to use the masses of water which rush wildly down the mountain sides as a means of producing electricity. Turbines placed at the foot of the falls are turned by the force of the water, and a dynamo is attached to the turbine and driven by belting. In this way no fewer than 12 towns in Switzerland are fixing up electrical apparatus for lighting and power purposes. In places where falling water abounds, electrical energy can be produced cheaply. As an illustration, it may be mentioned that an electrical company has been formed at the village of Faide, on the Gothard Railway, a place numbering 1,000 inhabitants. By means of iron pipe, a small supply of water is obtained from the neighbouring Pimmogna torrent, which drives below a small high pressure turbine, which in turn drives a dynamo supplying 360 glow lamps. The whole cost is under £2,000, which sum is divided into shares of £15, the owners forming the company. In this manner, in addition to the streets and railway station, the peasants and working-men have their houses supplied very cheaply with the electric light, which is elsewhere regarded as a luxury, but which Prof. Preece regards as a great sanitary agent.

When Mr. W. B. Bryan, C.E., was the borough engineer of Blackburn, he had to deal with the sewage of a district which had been newly incorporated by an extension of the borough boundaries, and lying 24ft. below the sewage outfall. He therefore designed a pumping station, the engines to be actuated by pressure from the town mains. The pressure in the mains was 125lb. to the square inch. The engines worked automatically, and were capable of raising 1,000,000 gallons in 24 hours 24ft. high. Mr. Baldwin Latham in a number of cases has been using high-pressure water for transmitting power for automatically pumping sewage. At Friern Barnet, for instance, he is transmitting power from the sewage works to a point a mile distant, and lifting the sewage of an isolated district 55ft. high into the gravitation sewers. Sewage is raised at Brentwood by means of a waterwheel. Small motors driven by sewage are used for working lime-mixers, etc.

In connection with power mains, a small jet of high-pressure water injected into a larger jet from the water works mains intensifies the pressure of the latter in the delivery hose, and also increases the quantity. A pressure of 40lb. to the square inch in a water main will throw the water issuing from a hose to the height of from 40ft. to 50ft.; but if water is turned on through a ⅜in. opening from the high-pressure main of 750lb., the water will rise to a height of from 90ft. to 100ft. through the atmosphere. Sir E. M. Shaw says this result would be very satisfactory, the pressure being as great as from a fire engine.

Another application of water power was made in the iron subway under the Thames just below Kingston Bridge. The subway was constructed of cast-iron plates bolted together in segments, forming rings 18in. deep, the diameter being 9ft. The method employed in driving the tunnel and fixing the plates was similar to that adopted in the construction of the City and South London Electric Railway. An iron shield of slightly larger diameter than the subway itself was forced forwards into the clay by powerful hydraulic jacks for a distance of about 18in., sufficient to insert one ring of the cast-iron plates. The Tower Bridge is provided with two steam pumping engines for hydraulic machinery, each 360 h.p., eight large hydraulic engines, six accumulators, and four hydraulic lifts in towers for passengers. The hydraulic forging presses at modern engineering works far exceed the Nasmyth hammer, which was once considered to give wonderful results. These presses are of 4,000 tons, and are worked by 2,000 h.p. pumping engines, and commanded by travelling cranes capable of lifting 150 tons. Altogether, hydraulic power is very serviceable in the working of ponderous machine tools, as it is also in the working of cranes, etc. We are indebted to water power in no small degree for the cleanly and noiseless lifts which are the comfort of lofty houses and flats.

No doubt the efficient utilisation of water power presents many difficulties which it is the duty and privilege of engineers to overcome. Surely there is a splendid field in many directions for the employment of such a well understood natural power as that of water.

SOCIETY OF ENGINEERS.

VISIT TO THE FERRY WORKS, THAMES DITTON.

On July 20th, a visit was paid by the members of this society to Messrs. Willans and Robinson's works. The Ferry Works, Thames Ditton, were started in the year 1881, for the construction of steam launches and yachts, and for the manufacture of the marine form of the Willans engine, as then made. Soon after the engine was modified for land work, and was applied extensively for electric lighting, and in 1885 the present pattern, well known as the "central-valve" engine, was produced.

In November, 1888, the works were almost completely destroyed by fire, and in the following year they were rebuilt on a greatly improved plan. They include at present a foundry, containing a 20-ton traveller, driven electrically, and two cupolas, with fans driven by electric motors.

Close to the foundry is the machine shop (about 140ft. by 120ft.), a one-storeyed building, with a gallery along the west side. It has a weaving-shed roof, the light coming from the north, and is divided into six similar bays, with interchangeable overhead travellers. At present, one bay is used as a store for manufactured parts, and one corner of the building is also used as the experimental and testing department, but a new building is to be erected for this purpose in the space between the present machine and erecting shops. The present testing department boiler is capable of supplying steam for about 200 i.h.p. or 250 i.h.p. up to 200lb. pressure, but two other boilers of equal capacity have been ordered, as well as a water-tube boiler for exceptional pressures, so that when the new testing arrangements are complete the largest engines at present made by the company—of about 700 i.h.p.—will be able to be tested to full power under steam before going away. Brake apparatus equal to at least this horse-power will also be provided.

The erecting shop, measuring 100ft. by 60ft., is commanded by an electrical overhead traveller, capable of lifting 25 tons, and, like the machine shop, has a weaving-shed roof, with north light; adjoining this is a building containing the pattern shop (the machinery in which is driven by an electric motor), pattern stores, and a mess-room.

A complete system of gauging is in operation, and all parts of the engines are standardised, and are as far as possible kept in store.

A rigid system of inspection of work prevails, both after each operation, and when the parts are finally passed into store. The inspectors are furnished with minute instructions as to the allowable deviations from standard dimensions, and are held responsible for any errors which may pass them. All work is passed through the stores on completion, and not directly to the erecting shop. There is a very complete apparatus for standardising electrical instruments, and the appliances for steam engine testing are probably inferior to none in existence.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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TRAMWAY WORK.

The paper of Mr. Cox read before the Municipal Engineers, and given in our issue of last week, has created a considerable amount of interest. The county borough of Bradford has done much to solve the problem whether it is best for the local authority to carry out its own lighting or be dependent upon a supply company. Our contention, which has not been ineffectively advocated, is that the municipal authorities should carry out their own lighting; if this course is impossible, the next best thing is to form a local company, and only as a last resource should an outside company be permitted to do the work. Naturally, the local company will in many cases have to be promoted by outsiders. Bradford took the best course, and carried out the experiment of supplying current. The weak points of central station work soon made themselves known to men accustomed to make money by the use of machinery, and they looked around for means to get a fuller load on during a longer period of the day. It so happened that some new tramway work was projected, and it was thought that electrical energy would be just the thing to use. The use of electricity would kill two birds; it would put a more constant load on the station, and would get rid of the objectionable steam traction. Hence the authorities determined upon an experiment that should give them data to consider the application of electricity for the whole traction on the projected line. The results of the experiment and the conclusion of the borough engineer are set forth in his paper. We have, however, to notice that he has—and we think, from his point of view, justly so—put the worst construction upon the experiments, so that if the Council determine to continue with electricity they may know the very worst that may happen. Still, it would be very safe to prophesy that from the figures given deductions of a vastly more favourable character as regards expense can be made, and it is tolerably certain would be nearer the true result when the annual balance-sheet of a year's normal working was made out. Thus Mr. Cox's estimates are worked out on a 2½d. basis per B.T.U., while he admits that the current could be supplied at 2d. per B.T.U., that an independent firm have offered to supply at this lower price. This means of course that the central station would and could supply at the lower price. Then again in the discussion, Mr. Cox himself—and others—drew particular attention to the low annual mileage of 80,000 miles. Many of the items in the estimate would be reduced with a large mileage. The estimate of the engineers—Messrs. Easton and Anderson—although also based upon 80,000 car miles, comes to only 8·324 pence. In this latter estimate current is taken at 2d. per B.T.U., which results in 2·784 pence per car mile, as compared with 3·920 pence of Mr. Cox. There is another point to which attention might be called. In an experiment the engineers would naturally be on the safe side as regarded the power, but when continuous running was the order, economy, always keeping in view efficiency, in every direction would be sought; hence, minor alterations in mechanical details as warranted by experience

would almost certainly further reduce the cost of current per car mile. It seems also that a saving ought to be made in the equipment of such lines. We know of at least one 'bus company that has twenty-five cars running to one idle. Mr. Cox estimates four cars running with three idle, that means between 40 or 50 per cent. of rolling-stock idle. Would not the proportion of one idle to three running be sufficient for every purpose? These are just some of the criticisms which Mr. Cox's paper demands, for it must never be forgotten that the duty of the borough engineer is to guard his council, and hence to exert the utmost caution in preparing reports and estimates. It is better for him to pluckily err on the safe side than to cut matters so closely that little margin for eventualities is allowed. We trust, in considering Mr. Cox's report, the Bradford Corporation will also give due consideration to the views we have advanced and to others of a similar character. The estimated return for the Wakefield-road line is much less than is obtained on some other of the Bradford lines, and it is to be remembered that almost without exception the introduction of electric traction upon tram lines has been followed by an increase per car mile in the receipts.

CLAYBURY TENDERS.

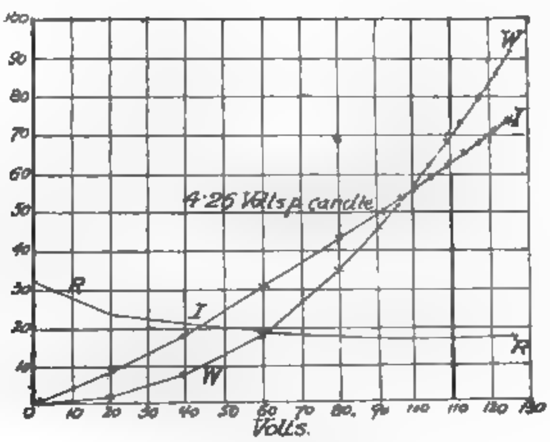
On Wednesday the *Contract Journal*, which, as most of our business readers know, makes a speciality of giving results of tenders, gave the list of those received by the London County Council for the electric lighting of Claybury Asylum. The list is a startling compilation, because it knocks the bottom completely out of all preconceived notions as to the knowledge electrical firms have of tendering. The lowest tender was to the amount of £13,970, the highest £28,400 — a difference of £14,430, or some £460 more than the total amount of the lowest tender. It is difficult to understand this, especially as in this case contractors were not left to their own sweet devices, but tendered upon the same specification. As one contractor remarked, "Our tender could well have been £3,000 or £4,000 lower had we been able to modify the specification in a way that would really have made the work better." There is no wide divergence between successive tenders; it is only when we come to a summation of a large number of tenders that the amount becomes startling.

THE NEW TELEPHONE COMPANY.

The prospectus of the New Company is before us, and, as might have been expected by the references made at the meeting of the National Company the other day, shows a compromise has been effected, and that amicable arrangement is to take the place of fierce competition. It was clear to all who had studied the subject that one or other company would have to take a back seat, and perhaps the best result that could have happened is the combination. By it the National practically admits its service to have been far from perfect, and that the New has something better to propose. The National takes all the shares that the rules of the Stock Exchange allow, nominates one-half the Board, and still retains control of the telephonic interest for the country. If recent agitation leads to a cheap and efficient service, the needs of the public will be served, for it is hardly in the nature of a prophecy to foreshadow the total amalgamation of the two concerns before many years are over, unless some wise Government plucks up courage to take over the work. So far as London is concerned, we may look for a gradual development of the twin-wire system till the whole system is complete, and no subscribers are left in any other direction. The decreased rate of subscription should bring additional thousands on the exchanges, and it is only when every house has its telephone that the full benefit of this modern invention will be understood. It is difficult to know whether to congratulate the National or the New upon the result, but at any rate the former has shown its wisdom in falling into line, while the latter has secured an easier task for providing a system which all competent persons allow is far preferable to that we have been accustomed to in this country.

VARIATION OF VOLTAGE AND EFFICIENCY OF LAMPS.

The influence of the variations of voltage upon the efficiency of incandescent lamps is a subject which specially appeals to supply companies' managers and engineers. M. G. P. Roux, of Paris, has communicated to us, as below, the results of a series of tests which he has recently carried out to determine the consumption in incandescent lamps under different voltages. These tests were made with an Edison-Swan lamp of 16 c.p., 110 volts, with a normal consumption of 4 26 watts per candle-power.



CURVES OF EXPERIMENTS ON INCANDESCENT LAMPS.

Energy 4·26 volts at the thick line (110 volts). Resistance, R, cold at start (by bridge) 321 ohms. Resistance, R, at finish 172 ohms (calculated).
I = $\frac{1}{100}$ths of ampere. W = watts. R = 10 ohms.

In the first set of tests, the results of which are given in Table I., and in the curves of the diagram, it is shown that the resistance of the lamp diminishes as the pressure increases, which means that the watts absorbed increase more rapidly than the *square of the voltage*, and that an increase of 2·24 per cent. of watts must be reckoned, for an increase of 1 per cent. in the volts—in other words, an increase of 3 volts on an ordinary circuit—means an increase of about 7 per cent. of electrical energy absorbed.

The tests were commenced at 20 volts and carried to 126 volts. The figures in the first and second columns of Table I. were taken with a Deprez-D'Arsonval galvano-

meter standardised with a Post Office standard battery, 1·07 volts, and a Fery standard cell.

Table II. shows the percentage of increase of consumption of energy in the lamp for variations of voltage within the ordinary limits. The mean is 2·24 per cent. for 1 per cent. of variation of voltage.

TABLE I.—TEST OF AN EDISON SWAN LAMP, 16 C.P., 110 VOLTS.

Volts. E.	Amperes. I.	Ohms. $R = \frac{E}{I}$.	Watts. W=E I.
0	0	321*	0
20·3	0·085	239	1·725
39·1	0·186	210	7·42
60	0·309	194	18·52
80·3	0·437	183·5	35·1
91	0·502	181	45·7
97	0·538	180·3	52·15
101	0·565	178·9	57·1
105·5	0·592	178·1	62·5
109·5	0·620	176·9	67·9
113·7	0·647	175·8	73·6
117·9	0·675	174·8	79·6
121·9	0·702	173·6	85·6
126	0·733	172	92·4

* Measured on bridge.

TABLE II.

Variation of voltage. Per cent.		Variation of energy. Per cent.		Variation of watts for 1 per cent. variation voltage.
105·5 to 109·5	3·85	62·5 to 67·9 ..	8·8	2·29
109·5 to 113·7	3·85	67·9 to 73·6	8·2	2·22
113·7 to 117·9	3·8	73·6 to 79·6 ...	8·3	2·19
117·9 to 121·9 ...	3·4	79·6 to 85·6	7·7	2·27
			Mean.. ...	2·24
109·5 to 121·5. .	11·2	67·9 to 85·6 .	26·2	2·36

It is certain that the lighting power is increased at the same time as the voltage, but not in the same proportion, and there remains here a defect which the constant progress in the manufacture of incandescent lamps will certainly cause to disappear, so that the consumer could be charged not by consumption of energy in his lamp, but rather by the amount of light supplied.

ELECTRIC CONDUIT ROAD IN CHICAGO.

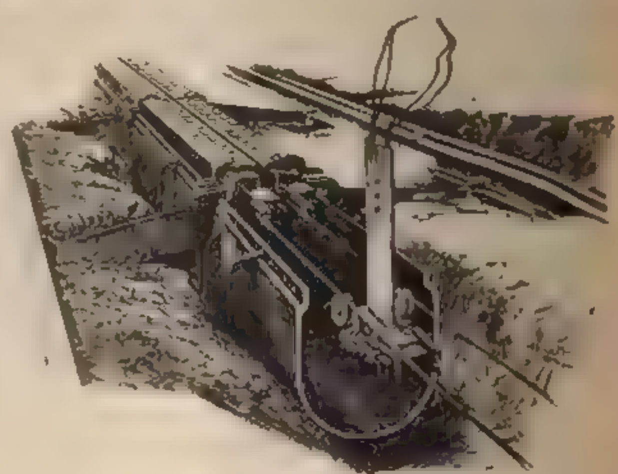
While the hot battle for and against the overhead trolley has been going on between the street car companies and the municipal authorities in various cities, resulting in New York and Chicago in the adoption of the cable, a street car company in the latter city has been experimenting quietly with a conduit electric road in order to satisfy itself on the question of the possibility of working such a road successfully. This road has now been running a number of months, and from all reports appears to have given complete satisfaction; a short description of it may therefore be of interest.

The conduit used is that known as the Love system, already mentioned and illustrated in our issue of July 4, 1891. It has since been changed slightly in details and improved in accordance with requirements which its introduction into practice have shown to be necessary. Much of its present success is due to the earnest efforts of the general manager, Mr. Albert G. Wheeler.

The accompanying illustration explains itself and needs little comment. One of the important features is that the top cover of the conduit consists of rolled steel strips or angle irons, having a deep vertical flange on the side bounding the slot. These angle irons are laid in long lengths, being secured in place by the clamps shown, by releasing these fastenings, which is a very simple matter, the angle-irons are readily removed, which open the conduit and renders it easily accessible for examining and repairing the wires, cleaning the conduits, and other purposes. This appears to be a very important feature, as one of the difficulties with a conduit is usually its inaccessibility, unless made large enough to admit a man, in which case it becomes expensive. It is stated that it requires but a few men and a very short time to open long lengths of the conduit.

The flange on the slot side extends lower down than the wires, and therefore protects them in a measure from interference on the part of the meddlesome small boy, who in other systems delighted in poking wires into the slot and seeing the sparks fly. It will be noticed, too, that both lead and return are insulated, which overcomes a number of difficulties experienced on grounded railroad circuits, and too well known to be enumerated here. The overcoming of these difficulties is by no means a matter of small importance.

Another feature is the means of support and insulation of the trolley wires, as shown in the cut. Great difficulties were at first experienced in the insulated support, but they claim that the present form overcomes all this, and that it is perfectly satisfactory, the wires being well insulated even in very wet weather, and when the streets are flooded with water. As will be seen, this arrangement takes care of the expansion and contraction of the wires. The rest of the conduit construction, with the rail supports, roadbed and rails, are said to be the same as those of the best cable roads.



The Love Electric Conduit.

One of the parts which was very troublesome at first was the trolley itself, but now they state that they have overcome this also, and that the very simple form of trolley shown, which is the one used now, is perfectly satisfactory. The trolley wheels are slightly smaller than those used on overhead roads and are loosely supported so as to admit of a small amount of play in all directions, just enough to adapt themselves to the inevitable slight irregularities, chiefly at curves. The whole trolley bar is easily detached and replaced if broken.

The conduit is well drained by means of frequent pipe connections to the sewers and settling-boxes. In order to clean it of mud and other sediment, a brush is attached to the trolley, which sweeps the dirt into receiving-boxes.

The road is 1⅝ miles long, embracing four curves of 35, 45, and 55 degrees radius, two double and two single track crossings and 10 switches. It was built during the past winter on the tracks of the North Chicago Street Railway Company.

That the road has been running quite successfully is best shown by the fact that the North Chicago Street Railway Company has accepted the road. In a letter from President Yerkes, of that company, he says: "So far as the system itself is concerned it gives us perfect satisfaction, and contrary to my fears the insulation is not interfered with in any manner by moisture. We have had some of the most severe rains in this vicinity during the past three or four months that I have ever experienced, so much so that at one time the cars ran through water on the track 3in. or 4in. deep, the trolley in the conduit running in the water owing to the inability of the sewer connections to carry off the flood fast enough, but at no time was the road stopped from this cause." After referring to some unfavourable

same voltage. Each of these armatures had been recently repaired, and although they had been well baked there may have been some leakage through the green shellac. The Foucault current in the cores were probably greater than in the new armatures. With the same armature and fields

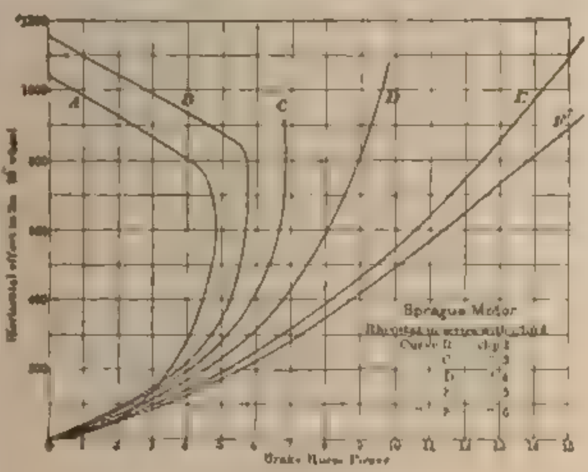


FIG. 5.

the efficiency is a few per cent. higher cold than when hot. It has been the aim to run as nearly as possible at the temperature of ordinary running, so that the fields were comfortably warm but not hot. It is confidently believed that the efficiency of these machines would be considerably above 90 per cent. if taken at armature shaft and with full voltage.

heavy. On starting the car the current is very heavy and the field is saturated with a small number of turns, hence the torque with a given current is nearly the same, whatever the windings of the field. The speed and counter E.M.F. are small at starting; hence the potential difference at the armature brushes should be reduced until it passes only enough current to start the car without jerking. The easiest way of reducing the potential difference at the brushes is by interposing resistance; and the heat developed by the C^2R can be cared for more easily and cheaply in an open rheostat than in the field coils. Rheostats of iron and mica are cheaper and more heat-proof than cotton-covered wires. This forces the conclusion that for the heavy load due to accelerating the car at starting, the field should have the smaller number of turns, and as the car reaches normal speed, and the horse-power and C becomes less, the efficiency of the motor would be raised by increasing the number of turns in the field. This conclusion is exactly the reverse of the common practice of manufacturers who sacrifice some efficiency for speed at small horse power. It is also in line with the experience of the road mentioned, that replaced the commutated fields with a single series coils of No. 7 wire, and later with No. 5 wire. This heat loss could be saved, and the average efficiency raised by using the two motors in series at the start, and afterward cutting out one or putting the two motors in parallel if necessary, as the speed increases and horse power decreases. An average of 12 tests on the road shows that with two motors on a car it requires 27 per cent. less current if only one is working.

In Fig. 3, Curve A shows the efficiency of Sprague motor with single pair of coils when the whole of a Thomson-Houston rheostat is in circuit. B shows about three-fifths

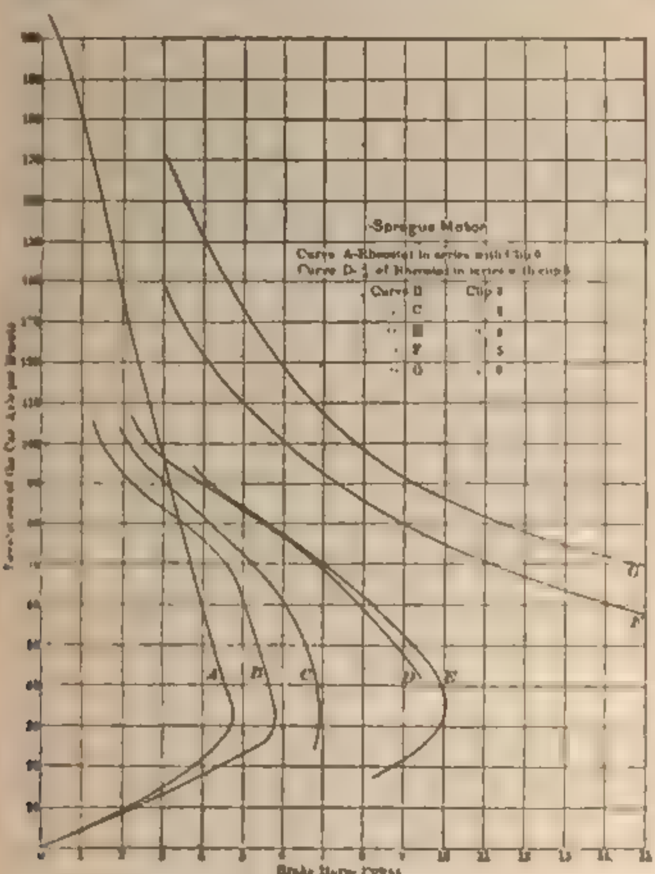


FIG. 6.

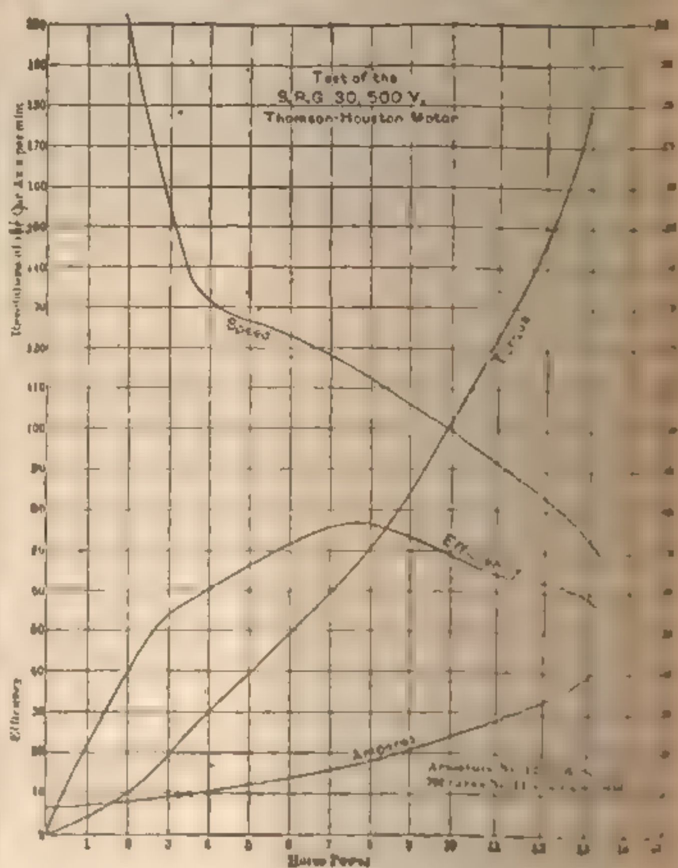


FIG. 7.

Fig. 1 shows efficiency curves for the motor, with different combinations of the field coils.

In Fig. 3, Curves A and B show efficiency of the machine with 857 and 611 turns of No. 7 wire in the field coils. It will be noted in Figs. 1 and 3 that the motor has highest efficiency with the larger number of turns on field coils until the iron is saturated, when the better efficiency is given with smaller number of turns and consequent lower resistance in field. This shows the advantage of working on the fifth and seventh clips with barrel regulator, or of cutting out part of the turns on field when the load is

of the rheostat in use; and in C it is all out. The dotted line, A^2, gives the efficiency as calculated from the difference of potential about the motor alone. Curve A, is not strictly comparable with the others on account of the necessary variations in the voltage at the motor, but it does show the increased efficiency to be obtained by utilising the superfluous voltage in a second motor in series. In this connection it is interesting to note that the resistance of rheostat, as calculated from current and potential difference, decreases with increase of current. This is to be expected, since the larger part of the resistance is due to

surface contact between the plates of iron in the rheostat, these being pressed together more closely as the iron heats. A similar effect, but much more marked, has been noticed in earlier experiments by one of us, with alternate plates of carbon and iron.

Figs. 4, 5, and 6 show curves of torque, speed, and horse-power, referring to the No. 6 Sprague motor. In Fig. 5, A shows horse-power and horizontal effort on a 30in. wheel; B, C, D, E, and F clips 2, 3, 4, 5, and 7, respectively. In Fig. 6 A shows speed and horse-power, with all of the rheostat in; E with ⅗ of rheostat in; B, C, D, F, and G clips 2, 3, 4, 5, and 7, respectively. These may be compared with results presented by Prof. S. H. Short before the Chicago Electric Club, March 28, 1892. Fig. 7 gives curves of current, torque, speed, and efficiency from a 15-h.p. Thomson-Houston single-reduction motor. The reduction ratio is 4·7857.

(To be continued.)

ELECTRIC SWING.

Mr. Volk, of the Brighton Electric Railway, has devised an electric attachment for swings. The direct pull of a solenoid is utilised, the core of the solenoid being connected with a wire cord, which passes over a pulley, then horizontally to the side arms of the swing.

The make and break action is rather peculiar, as with the reversal of the motion of the swing the contact is made and broken independently of the angular motion of the swing. This is effected by means of the wire cord running through a gripper attached to the contact lever, so that the cord slips freely through the gripper after carrying the lever to either extreme of its motion. The current is about three-quarter amperes at 160 volts. The motion is said to be peculiarly smooth and pleasant.

ELECTRIC CLOCKS.

The merits of the self-regulating electric clocks recently exhibited at the Crystal Palace Exhibition by Messrs. Shippey Bros. are beginning to make themselves known, for we learn that this firm are busy fitting up sets of these ingenious clocks in country mansions, also in several engineering works and public buildings in various parts of the United Kingdom. During the past month, amongst others, they have carried out private installations for Mr. Gilbert Harrison, "Manx View," Carnforth; Captain Bilton, Norfolk-square, Brighton; Mr. L. M. Barron, Slough; Mr. Valentine Holmes, Frithville-gardens, W.; Mr. Henry Bevan, South Woodford; Messrs. Amos and Smith, where clocks are under test at the Victoria Docks, Hull; the offices of Messrs. J. H. Burt and Co., Cannon-street, and numerous other public buildings and mines in England and Wales.

The principle of these clocks is simple; for instance, in the hall of a private residence, or in the chief offices of works, a standard electric regulator is placed. This regulator works by its own action for, say, 59½ seconds, when electric contact is made and a magnetic pull is exerted, and during the remaining half-second required to complete the round of the minute wheel an ingenious contact arrangement lifts a small ball and momentarily breaks the circuit, so that the wheel becomes free again. Then by the aid and momentum of the pendulum the motion is continued, and the automatic electric action goes on perpetually day after day, year after year, for one, three, or five years, according to the battery power supplied.

The regulators, which are made in three sizes according to requirements, are capable of regulating sets of either 10, 20, or 30 secondary clocks connected in series, and these can, of course, be fitted in various parts of the house, buildings, works, or railway stations, as the case may be, and thus can be successfully driven by four to six volts of intermittent current within a radius of two or three miles. The secondary clocks, being in sympathetic action with the main circuit clock, are electrically regulated every minute, and it is claimed as part of the invention that by this method no clock can deviate from each other for more than one second under any conditions whatever. The system, which is covered by several patents in all countries, is the invention of Mr. E. Schweizer, and as an illustration of the success of the system when worked on a large scale, it may be mentioned that the municipality of Vienna has had working for some time past over 600 of these clocks, regulated from four main centres; standard time is thus assured in all parts of that city. A special type of clock is also manufactured and supplied for fixing up in central electric stations, which is guaranteed to be no way affected by the vibration of the machinery or magnetism of the electric plant. The progress of this new system of horology bids fair to make it one of the important inventions of the age, and it will be watched with interest by all firms or authorities seeking to secure a reliable clock which will without trouble give uniform correct standard time.

ON THE APPLICATIONS OF ELECTRICITY IN THE ROYAL DOCKYARDS AND NAVY.*

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This is an age of electricity; and the fact is well exemplified on board a modern battle-ship of the Royal Navy. Some of the applications of electricity in the naval service do not come within the scope of ordinary mercantile practice; and in the case of those which do, the naval experience is of a special kind, and may be of some value to those outside the service. A statement therefore of naval methods and practice up to date may not be without interest and instruction to the members of this institution. At the present time visitors to Portsmouth Dockyard will probably be surprised, if not disappointed, at the somewhat primitive character of the workshops devoted to the electrical testing and construction. This branch of work was commenced in a very small way about 17 years ago, and found a temporary home in a small shed which had been previously used for a different purpose. As the work from time to time has grown, this shed has been enlarged as far as available space would permit. Designs have been prepared for a more substantial and suitable building, in the hope that in time the Admiralty will be able to devote sufficient money to providing a proper habitation for this important branch of dockyard work.

The larger proportion of the plant required for electric installations in the navy is not made in the dockyard. Formerly all dynamos and their engines were obtained entirely by contract; but recently five sets of these have been designed and constructed in the dockyard. After patterns of the smaller fittings have been fixed, the supply of these also in bulk has generally been obtained by contract. There is, however, a great deal of work left to be done in the dockyard, in testing and installing these fittings in the ships, in carrying out repairs, and in devising and preparing patterns of new fittings to meet the constantly growing requirements of the navy. There is also some work which for obvious reasons is confined to the Royal workshops.

The applications of electricity in the navy may be dealt with under the following heads: (1) Search-lights; (2) internal lighting of ships, including temporary installations in ships building and repairing; (3) torpedo and gun circuits; (4) electric communication; (5) other applications.

1. Search-lights.

The introduction of the search-light—without which no modern warship or torpedo-boat would be considered complete—dates from 1876; and the first vessel in the navy fitted with a search-light apparatus was the "Minotaur." Some experiments had been carried out in the previous year by Messrs. Wilde and Co., of Manchester, on board the gunboat "Comet"; and these proved so far satisfactory that a complete plant was ordered and fitted on board the "Minotaur." The dynamo employed was one of the alternating-current type with 32 magnets, and it was driven at about 400 revolutions by a belt from an auxiliary pumping engine. The projector was of a primitive type, and pedestals were fixed in three different places, from any one of which the same projector could be used. It was fitted with a parabolic reflector and with dioptric and diverging lenses. A diaphragm was also provided for enabling flashing signals to be made. The lamp employed was Wilde's, and was a vertical one. The carbon rods were square in section, and their holders were made to slide on two pillars, and were moved up and down by a central pillar with a screw thread cut in it. The lamp was hand-regulated, and one lead was put to earth. The "Téméraire" in the same year was next fitted in a similar manner, with the exception that a Mangin projector was introduced, fitted with Wilde's lamp, lens, etc. In the next year, 1877, the "Dreadnought," "Neptune," and several other vessels were fitted with the same class of apparatus.

In 1878 direct driving was first introduced. In this year Messrs. Wilde and Co. coupled their machines to engines made by Brotherhood and by Chadwick, of Manchester. The dynamo was also improved, so as to be able to maintain two arc search-lights at one time. In the same year also the "Triumph" was fitted by Messrs. Siemens Bros. with a search-light installation. The dynamos were four in number, of horizontal type, arranged in two pairs, and each connected in parallel to one circuit. A switchboard was fitted, for enabling any two of these dynamos to be coupled up together on any circuit. It consisted of a wood base with two sets of bars at right angles to each other, one set on the top of the base, and the other underneath. One set of bars was connected to the dynamos, and the other to the circuits. At their intersections these bars could be connected as required by means of suitable plugs. The projector used was a Siemens holophote, which was heavy and clumsy, being made largely of cast iron. It was fitted with diverging and dioptric lenses. Of these, the latter was com-

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posed of concentric glass rings of triangular section, held in a metal frame. It had also a flashing arrangement. The lamp used was one of the Siemens self-regulating type, and had a small mirror fixed to it. It was complicated, and frequently got out of order. The carbons were apt to stick together, and the lamp was sensitive to any slight variation in speed of dynamos. This lamp did not come into general use.

Subsequently, the Gramme dynamo was introduced for search-lighting by Messrs. Sautter Lemonnier, of Paris, and in 1881 the "Inflexible" was fitted with this dynamo. In this installation the Mangin projector was used, with a Mangin mirror instead of the dioptric lens. The lamp was hand-regulated and inclined. The Gramme dynamo has since been superseded by others of later make, but the Mangin mirror and the inclined hand lamp survived, and became the standard service fitting.

Naval Service Projector.—Out of these earlier attempts the modern naval service projector has gradually been evolved, which has now become familiar to most persons. It consists of a cylindrical lantern made of very thin steel, with a silvered glass parabolic mirror at the back end, in the focus of which an arc light is produced between two carbon sticks, held in what is known as an inclined hand lamp, the carbons standing at an angle of about 70deg. to the axis of the mirror. The feeding of the carbons is not automatic, but is accomplished by hand; and the lantern is so suspended that it has motion on its pedestal through the whole circle in azimuth and through about 60deg. in altitude. During its motion the electrical connections are kept up by suitable rubbing contacts. A switch is fitted in the pedestal for switching the current on and off. The circuit wires, main and return, are brought from the main switchboard to the switch on the pedestal, thence to the rubbing contacts, and finally pass close together up one of the hollow arms of the lantern support, and through the trunnion-bearing to two springs at the bottom of the lamp box. The lamp when put in makes contact with these springs, and completes the circuit through the carbons. Two sizes of these projectors are used in the naval service, a larger with a 24in. mirror for ships, and a smaller with a 20in. mirror for torpedo boats. The parabolic mirror in these projectors converges the rays into a powerful and penetrating cylindrical beam of light. At the front end of the lantern, diverging lenses can be attached, for spreading the beam over a larger surface when desired; or a flashing screen can be affixed for signalling purposes. The two most important parts of these projectors for the production of a good and steady beam are, of course, the reflecting mirror and the carbons. For the supply of these articles the naval service was until recently dependent entirely upon French manufacturing firms. The Admiralty, fully alive to the dilemma in which this country might, under certain circumstances, be placed, have sought to induce English manufacturers to enter into competition with the French firms for the supply of these articles; and every thing of this kind which has been offered with the slightest promise of success has been fully and carefully tested at Portsmouth. The English manufacturers have no doubt had no easy task to accomplish; for, disregarding cost, the French mirrors and carbons left nothing to be desired, and are still the standard to which all others are referred.

Mirrors.—As regards mirrors, the qualities required are three: first, that they shall project a cylindrical, sharply defined, and homogeneous beam of light of great intensity and penetrative power; second, that when in operation they shall not be liable to crack by contact with water, in the form either of rain or of sea-water spray, or by a blast of cold air; third, that they shall resist the concussion caused by the discharge of heavy guns. These qualities should be combined at a moderate cost if possible, although efficiency is the primary consideration. Thus far mirrors have been submitted for trial by six different English makers, and by others specimens are being prepared for future trial. From among these at least one successful English specimen has been obtained, which compares in all points favourably with the French production; and one half of the supply for the navy will this year be ordered from the firm producing this specimen.

Carbons.—With regard to English carbons, the results were for a long time disheartening, even after several attempts by the same firm, none of the specimens submitted for test approached in efficiency those of French make. The three qualities required in good carbons are that they shall maintain a steady arc without flaming or excessive hissing; that they shall be perfectly pure and homogeneous in structure, and shall preserve a well formed crater on the positive carbon and a well formed point on the negative; and that the waste shall be steady and uniform, without cracking or crumbling. A certain amount of success has already crowned the persevering efforts of English manufacturers. Although the English carbons are not even yet fully equal to those previously obtained from France, it is hoped they will soon come sufficiently near that standard to make them acceptable for use in the navy.

Projector Requirements.—The present service projector requires at least one man close to it, to direct the beam of light in any desired direction and also to feed and adjust the carbons as necessary. This is a disadvantage, because the position of a search light is evidently one affording a good mark for an enemy's fire, and is a bad position for observing the object illuminated, and it would be an advantage if the projector could be entirely manipulated from a protected position at some distance—for instance, from the ordinary conning tower. For this purpose two requisites are necessary: first, a good automatic lamp; and second, an efficient motor for giving the necessary movements to the projector. It is to these two improvements that attention is now being given. A good practical automatic lamp is the first necessity; without this a man must be stationed at the projector to feed the carbons, and being there he can also direct the beam of light. Several automatic lamps have been tested, but none have as yet been adopted for general use. One lamp, in which the carbons are regulated by a small electric motor in a shunt circuit, is promising, but, in its final form, it has not yet been returned from the makers. The field, however, is still open for invention in this direction. Experiments have also been made with an electric motor attached to the service projector, by which the movements of the latter can be directed and controlled from a distance. The results are highly satisfactory, but, as already stated, the invention is not likely to be brought largely into use until it can be combined with a satisfactory automatic lamp. Recently a wheeled carriage has been introduced for using a ship's projector on shore.

2. Incandescent or Glow Lamp Lighting.

Electricity is at the present day largely resorted to for the purpose of lighting internally the vessels of the navy; all the larger vessels, such as battle-ships and first and second-class cruisers, are now so lighted. Moreover, this mode of lighting is not restricted to the habitable portions of the ship, but is carried out to the complete exclusion of other modes, although the latter may be fitted as a reserve. Thus the electric lighting is extended to machinery spaces, coal bunkers, magazines, shell rooms, store rooms, gun quarters, etc., as well as to the illumination of compass cards, telegraph dials, bow and masthead and signal lanterns, semaphores, etc. Clusters of glow lamps beneath an enamelled metal reflector are also employed for lighting the upper deck when coaling or other operations are being carried on at night. In a large battle-ship like the "Royal Sovereign" there would be about 800 of these glow lamps, necessitating for this system alone some eight miles of electric leads, which are equivalent to something like 155 miles of copper wire of varying sizes, principally No. [illegible] legal standard wire gauge, or 0·036in. diameter.

Progress.—The first installation of internal lighting in the navy was carried out on board the "Inflexible" in 1881 by the Anglo-American Brush Company. It was a combined system of arc and glow lamps. The dynamos used were of the Brush type, of which the first specimen brought to this country was purchased by the Admiralty, and is still in use in Portsmouth Dockyard. Each machine was capable of maintaining 16 Brush arc lamps of 2,000 c.p. each. The lamps had double sets of carbons, each pair burning eight hours. These arc lamps were turned on and off by a switch opening and closing a shunt circuit of low resistance. With this plan it is evident a lamp could not be handled while the current was on, even if the light was turned off, because the lamp itself still formed a part of the circuit. A switch was accordingly devised in the dockyard by means of which the lamp could be cut completely out of the circuit. The glow lamps were fitted in sets of 18 in series, each set being placed in parallel between the main circuits of the arc lamps. Each glow lamp was fitted with an automatic cut-out, bringing into the circuit a resistance equal to about that of the lamp, in case the latter failed. This system now no longer exists in the "Inflexible," an installation on modern methods having been substituted for it. The five Indian troopships were next fitted throughout with glow lamps by the Edison Company, who used the Edison Hopkinson type of dynamo, giving a current of 180 amperes at [illegible]. The "Polyphemus" was also entirely fitted by Messrs. Siemens, and the "Colossus" by the Brush Company, the dynamos in the latter being of the Victoria Brush type. The "Polyphemus" was the only ship in the navy fitted on the single wire system. Afterwards, the adoption of internal lighting became general; all new vessels, except the smaller cruisers, were fitted, as were also the previous vessels on the first opportunity of their coming in for repairs and refit. There are now in the navy about 300 vessels either fitted or being fitted with electric lighting for search lights or internal lighting, or both.

Difficulties.—The earlier installations, although quite satisfactory so far as the illuminating effect was concerned, were certainly not satisfactory in regard to the endurance of the plant; in fact, they were a constant source of trouble, both the dynamos and the leads requiring frequent repairs or renewals. These troubles arose partly from faulty construction, and partly from the conditions necessarily existing on board ships of war, such as the necessity for placing the dynamos well down in the ship and under protection from shot; which relegated them either to the engine room with its high temperature and moist atmosphere, or to some other confined and ill ventilated spot. Under these conditions the insulation soon suffered, and the machine quickly got out of action. The leads throughout the ship suffered from the access of salt water, which caused much trouble by destroying the insulation, and producing short circuiting, thereby frequently setting on fire the wood casing in which the leads were run, or any other inflammable material in the neighbourhood.

Remedies.—Nearly all these difficulties have in the course of time been surmounted. While it is still necessary to place dynamos under protection for use in action, it has now become the practice to fit an additional dynamo capable of running all the lights generally required at one time, and to place it with its motor in an open space between decks, or on the upper deck, suitably sheltered. This is known as the peace or daylight dynamo. The introduction of lead coated wires marked an epoch in shiplighting; and these wires are entirely used in all the new installations, and are taking the place of the old leads as fast as the latter require renewal. These cables dispense entirely with the wood casings previously used, resulting in greater simplicity of fitting as well as increased efficiency. The wood casings are still used in America, even with the lead coated cables, but in the writer's opinion, while adding largely to the cost of the installation, they are likely to detract from its efficiency, as they form such convenient receptacles for water to lodge in.

Dynamos.—The Admiralty have not adhered to any one particular kind of dynamo, for although those of the Siemens type predominate in the navy at present, nearly all the well known makers are represented—such as Latimer Clark, Muirhead, and Co., the Electric Construction Corporation, the Silvertown India-rubber Company, Goolden and Co., Crompton and Co., and Parsons and Co. The experience gained in the testing and use of these machines of different types was of immense benefit in enabling those points to be discovered in which dynamos are most likely to fail, and in suggesting the direction which improvements should take. The weak points in most of the machines supplied were imperfect insulation, owing to want of sufficient care in building, and the excessive internal heating of the armature. In some cases the section of copper used was too small, resulting in the heating of the dynamo and the rapid destruction of the insulation. By direction of the Admiralty a design was prepared by Mr. Lane, electrician of Portsmouth Dockyard, for a machine to give an output of 400 amperes at 80 volts, which should embody the experience already gained, and should be free from the faults previously mentioned. Five machines have been built from this design, two of them for the "Rupert," a vessel now under reconstruction No opportunity has yet occurred for testing them under the conditions of sea service, but two have been used for about a year under full load, as temporary lighting plants for ships building, etc. At times, too, they have been worked for long periods above full load, from 420 to 430 amperes; and they have always given perfect satisfaction. They are driven at about 330 revolutions a minute by open vertical compound engines of 56 i.h.p., designed and constructed in the chief engineer's department of the dockyard. The total weight of the dynamo and engine with bed-plate is about 5¼ tons.

Other Fittings.—As regards the other fittings required to complete a successful installation—such as switches, fusible cut-outs, lampholders, shades and their holders, etc.—patterns have been adopted or devised in accordance with accumulated experience, to meet the special requirements of the navy; those are simplicity, combined with strength to withstand the rough usage necessarily experienced on board a fighting ship. The guiding principle in the present installations is to make every part of the circuit inaccessible to water by employing lead-coated cables, and by enclosing in metallic water-tight boxes all the principal switches and cut outs, and by effecting in all cases in the interior of water-tight distributing-boxes the subdivision of the mains, which themselves pass into the boxes and their subdivisions out of the boxes through water-tight stuffing-glands.

Switchboard.—With several dynamos and a combined installation of incandescent and search-lighting, a good switchboard is a necessity. The one generally used in the navy at present is susceptible of improvement; and a new switchboard has just been designed and made by Mr. Lane, the dockyard electrician, which promises to fulfil all the requirements.

Temporary Installations.—The employment of temporary installations of electric lighting in ships building and repairing has been a marked feature of recent practice in Portsmouth Dockyard. Probably more has been done here in this respect than has been attempted in any other Royal dockyard or private shipbuilding yard in the country, although these are now finding it to their advantage to follow the lead. So highly satisfactory have been the results of the experiments in this direction, that, with the exception only of the smallest ships, the electric light is now installed as a matter of course on board every new vessel at an early stage of its construction, and also in all vessels where repairs of any magnitude are to be carried out. The character of these temporary installations varies with the circumstances of each case. Where vessels are building in the docks adjacent to the electric shop, it is, of course, more convenient and economical to supply the current from a dynamo in the shop itself, the leads being carried to the ship on temporary wooden poles put up for the purpose. Vessels building on the slips, which are too far from the electric shop to convey the current to them in an economical manner, are served by a dynamo and motor placed at some convenient spot near the ship. After a vessel is launched, and generally for all vessels afloat, the most satisfactory method is to place a dynamo and engine with a steam boiler in the ship itself, generally in a temporary wooden house on the upper deck. By this means the light is maintained without interruption during the many movements of the vessel about the basins. The leads, lamps, etc., are fitted roughly. The cables are simply tied to clips fastened to the beams, etc. The switches are hung from the cables. The lamps with their holders are secured to wooden bases, and protected by wire guards without any globes.

Cost.—Although no exact comparison can be given between the cost of this mode of illumination and that of the old plan of lighting by candles, it is estimated that in a first-class cruiser like the "Royal Arthur" the total cost of the electric lighting during the whole period of building, including depreciation of plant, would be about £1,200. This would probably not much exceed, if at all, the cost of candles for the same period; but the vastly superior illumination obtained by the electric light—enabling work to be done better, more quickly, and under better supervision, to say nothing of the advantages in health and comfort to the workmen—would justify the continuance of this system, even though the actual cost should be much greater than that of lighting by candles. It is hardly an exaggeration to say that the excellent results as regards celerity and cheapness of construction which have lately been attained in Portsmouth Dockyard, could scarcely have been realised without the aid of the admirable illumination afforded by the system of incandescent lighting.

Testing of Dynamos.—Before acceptance from the makers all the dynamos purchased by the Admiralty are tested on receipt at a dockyard; and as no less than 150 have been tried at Portsmouth during the last two years, 1890 and 1891, the experience gained has been considerable. At the north end of the electric shop a space is fitted with cast-iron holding-down plates, of sufficient area to take several sets of plant at one time, and also with an overhead traveller for lifting. Steam at 100lb. per square inch, or other pressure required, is supplied by three boilers of locomotive type in the adjoining boiler-house. Adjacent to the holding-down bed is a separate enclosed room, containing all the various electrical testing instruments; and into this room the leads from the dynamos under test are taken. For enabling a dynamo on any part of the holding-down bed to be rapidly connected up with the instrument-room, two bare copper rods extending overhead the whole length of the bed are fixed to the roof trusses and insulated by slate. From these are suspended two hanging leads, the lower ends of which can be connected to the terminals of any dynamo under trial. The overhead bars are coupled to leads, which pass through resistances sufficient to give the full load, and then into the instrument-room. Nearly all the dynamos now purchased, except those for torpedo-boats, are of a capacity of 400 amperes at 80 volts, the latter being the Admiralty standard voltage for all dynamos and electrical fittings; and they are all direct-current and compound-wound. The dynamos are coupled direct to open vertical compound engines, working generally with 100lb. steam pressure at a speed of about 330 revolutions a minute. The dynamo and engine are required to stand first a continuous trial of six hours' duration with full load. Every half-hour the steam pressure, current, and E.M.F. are recorded, as are also the temperatures of the testing-room, field magnets, and armature. It is stipulated that one minute after the end of the trial the temperature of any accessible part of the machine must not exceed that of the testing-room by more than 30deg. F., and the maximum temperature of the armature at end of trial after stopping must not exceed that of the room by more than 70deg. F. If these limits are exceeded by more than 10deg. the machine is liable to rejection. These tests for temperature are considered to be of great importance, for if unsatisfactory the dynamo is not likely to remain long efficient The spare armature which is supplied with each machine is required to undergo a similar test for two hours. The current produced by any dynamo is measured by means of a Siemens ammeter; and as a check upon this the current can also be switched on to a Siemens dynamometer. There are several of these ammeters, and three dynamometers, of different sizes to suit the current to be measured. The leads pass through sliding resistance-boxes, so that the strength of the current can be varied as required for the compounding trials. The voltmeter leads taken from the dynamo terminals are also led into the instrument-room, and the E.M.F. is ascertained by means of three Evershed marine voltmeters. A switch is interposed, of such a nature that either any one or any two or all three of these voltmeters may be in the circuit, thus checking one another's accuracy. A Cardew voltmeter and also a Siemens voltmeter can be switched in, if desired. The Cardew voltmeter and the Siemens ammeter are the instruments actually used on board ships of the navy. Very delicate instruments, such as electro-dynamometers, are found not to be suitable for use under such circumstances. As additional tests the engines and dynamos are expected to stand without injury the sudden removal of the full load by the breaking of the circuit; and under such circumstances the maximum increase in revolutions or in voltage must not exceed 25 per cent. The dynamos are required also to be compounded so as to give a constant E.M.F. of 80 volts when the current is varied from 400 to 10 amperes, the speed being fairly constant during the time; and they are fairly tested to ascertain that these conditions are fulfilled.

Engines.—As regards the engines, great importance is attached to their economy in the consumption of steam. The makers are required to state the consumption of water per electrical horse-power per hour which they will guarantee shall not be exceeded. A fine is incurred for every pound of water per electrical horse-power per hour in excess of the maximum guaranteed; and if the excess amounts to more than 10lb. per hour, the machine is liable to rejection on this account. The water used is carefully measured, and every endeavour is made to avoid losses by leakage of steam, etc Importance is also rightly attached to the governing arrangements, and it is stipulated that the increase of speed when the load is gradually removed must not exceed 5 per cent.

Resistances.—Before the six hours' trial is started, and immediately after its conclusion, the resistances are observed of the dynamo complete, of the armature, and of the shunt and series windings of the field magnets; the resistances are thus obtained both when the circuits are cold and also when they are hot. For this purpose the leads from the terminals of the part whose resistance is required are taken into the testing room, and the resistances are obtained by a bridge made by the Silvertown Company, by a Thomson marine galvanometer, and by an ordinary scale, for which the light is given by an incandescent lamp behind. The ordinary Daniell cells are used, and a key is introduced, so that one, two, three, or four cells may be switched in at once without altering the leads. The dynamo and engine are further tried when fitted on board ship, and when the whole installation is complete.

3. Torpedo and Gun Circuits.

Torpedo Circuits.—When the Whitehead or fish torpedo was first adopted as an element in the offensive armament of ships of war, it was ejected from its carriage by means of an impulse-rod or piston actuated by compressed air. The ejection was effected by opening a communication valve between the impulse cylinder and a reservoir of compressed air. As it was necessary that the discharge of the

torpedo should be effected from an observing and directing station remote from the torpedo itself, electricity was early pressed into service for effecting the communication between the observer and the firing valve, and in 1879 an electrical arrangement was first fitted for enabling the firing valve to be opened from a distance. The method of ejecting torpedoes from a carriage by means of an impulse rod was soon abandoned, however, and the air gun principle took its place. By this method the torpedo is itself placed in a tube or gun, into which compressed air is admitted behind the torpedo, and the ejection is effected by the expansive force of the air acting directly upon the rear of the torpedo, exactly as the explosive force of gunpowder drives a shot out of a gun. When worked from a distant point the firing valve was still opened by electricity, but on an improved plan. In the earlier ships the batteries were placed below the water line, and the circuits were complete with main and return wires. Where not protected by armour or not below the water line, the wires were duplicated and kept apart from each other, as greater security against both circuits being destroyed at one time from the same cause. The circuits now used are earth circuits and are duplicated where exposed, as for instance near the torpedo tubes. The standing wires of the modern circuits are lead coated. The conductor is formed of a strand of seven wires of No. 22 legal standard wire gauge, or 0·028in. diameter. It is insulated with indiarubber, which again is covered with three servings of cotton tape prepared with india-rubber. The enclosing lead tube is covered with a strong tape saturated with a waterproof mixture. Where flexible leads are required they are formed of 36 wires, each of No. 30 legal standard wire gauge, or 0·012in. diameter, insulated, as before, with indiarubber and cotton tape and protected by a binding of hemp. The whole is saturated with Hooper's composition. Within the last few years powder impulse has been introduced for discharging torpedoes. For this purpose a cartridge containing a small charge of gunpowder is placed in a powder chamber prepared for it at the rear of the torpedo tube. The cartridge is fired by means of an electric current generated in a local circuit, that is, by a battery secured to the torpedo tube itself. This local circuit is momentarily completed by the action of the firing circuit from the observing station.

Gun Circuits.—Electricity is further employed in the navy for effecting the discharge of guns, either individually at the gun positions or simultaneously in groups, from some protected observing station. So far as the writer is aware, this system was first practically employed about 1874, and the current was obtained by means of pile batteries. These were formed of about 160 elements, consisting of alternate copper and zinc plates separated by fearnought (a kind of flannel) dipped in diluted vinegar. With these batteries high tension fuses were used, which were not only dangerous, but frequently failed owing to the difficulty of keeping the circuits free from moisture. From 1874 down to about 1881 gun circuits were fitted as complete wire circuits. Now earth return circuits are adopted, except in some cases of auxiliary circuits which are still complete wire circuits.

Safety Arrangements.—These are highly necessary in the ordinary working circuit, in view of the possibility of the gun being fired prematurely with possibly disastrous results. For instance the gun might by mischance be fired before the breech block was properly replaced and locked, and to avoid this danger the circuit is broken automatically by the act of unlocking the breech and the connection is again made automatically in the act of relocking after loading. Again the gun might be fired after the breech block was secured, but before the gun was run out, in which case the energy of recoil would be expended in smashing up the gun mounting. To avoid this, the circuit is automatically broken at the front end of the carriage by the action of recoil, and is remade automatically just as the gun again reaches its run-out position. The making and breaking of the circuits are effected by means of rubbing contacts, and while these give assurance against an accidental discharge of the guns, they are not an unmixed good, as they sometimes cause a miss-fire, and a continuous protected circuit without any of these breaks would be more certain and reliable. In the earlier turret ships, especially in the rigged ones, the guns were masked by portions of the ship's structure at certain angles of training. In such cases devices were introduced for automatically breaking the firing circuit at these particular angles. In all the later turret and barbette ships the turrets or barbettes are placed near the extremities of the ship, and while having a limited arc of training, they are unobstructed in their fire throughout the whole of this arc when the ship is cleared for action. Consequently, there is now no necessity for any safety arrangements. In the modern, as in earlier ships, the full depression of the guns cannot be obtained throughout the whole horizontal arc of training, and the danger of firing into the deck is obviated by an ingenious automatic arrangement, which is in connection with the hydraulic or other mechanism for working the guns, and has nothing to do with the electric circuits.

4. Electric Communication.

The efficiency and safety of a modern warship are largely dependent upon the means of communication between the various working parts of the vessel. The officer directing from the conning bridge the movements of the vessel must have the means of instantly transmitting to the engine room a few prearranged signals with regard to the starting, stopping, etc., of the engines, and he likes to have the signal transmitted back to him to assure him that his order has been correctly received and is about to be carried out. When manœuvring in squadrons, in which his ship has to keep her correct station in relation to the others, he must be able to communicate to the engine room, for regulating small variations of speed, say, one revolution more or less over a considerable range of speed. He also likes to be able to ascertain for himself on the bridge the actual revolutions of the engines, and he prefers to do this at a glance without having to take the trouble to use a watch and count the revolutions, say, for a minute. Where the steering wheel is not immediately under his own eye as it generally is when steam or other mechanical power is applied for steering the ship, he likes to have an indication on the bridge that the rudder is properly responding to the motions of the steering wheel. Should either of the alternative steering positions below have to be resorted to, he requires a certain means of communicating his orders to the steersman at that position. In addition to the means of transmitting a few prearranged signals, he also requires a means of conversing from the conning bridge with the engine room, with the steering positions, and with a few other places. In action, when the vessel's movements may be directed from a protected conning station, he needs, in addition to the foregoing requirements, to be put in communication with the officers at the various gun quarters, including turrets or barbettes, and also with those at torpedo discharging positions, etc. In fact, he requires to be placed [illegible] directly or indirectly in communication with every part of the ship where officers and men are stationed. Where only a few prearranged signals are required, these intercommunications are effected by means of transmitting and receiving instruments either mechanical or electrical; while for communications of a general character voice pipes are employed. About six years ago many complaints were received from ships as to the unsatisfactory nature of the means of signalling and intercommunication, and as many new instruments, chiefly electrical, were then being proposed for use in the navy, a committee was appointed, consisting of naval officers, naval constructors, and marine engineers, of which the writer was a member, to enquire into and report upon the whole subject. In the course of the enquiry the views of a large number of representative naval officers were obtained, in order to determine, firstly, what intercommunication was necessary and best for a ship of war. On this primary question naval officers were not wholly agreed; but there was sufficient accord to [illegible] a standard method to be laid down. In order to arrive at the best means for effecting these intercommunications, the committee studied all the methods that had been previously tried, [illegible] those in use in the mercantile marine. They carefully [illegible] and tested many new instruments that were submitted [illegible] notice, and carried out a number of independent experiments.

Voice Pipes and Call Bells.—Among other means of [illegible] the committee recommended that all voice pipes [illegible] stations where there is noise or vibration, and all others [illegible] are over 100ft. in length, should be increased from 1½in. [illegible] diameter, the size then in use, to 2in. internal diameter, [illegible] with these larger pipes a system of electrical call bells [illegible] fitted. This plan is now generally carried out in the [illegible] has resulted in greatly improving the means of communication. The call bell arrangement consists of an ordinary push [illegible] the sending station, with the well-known annunciator or [illegible] shutter instrument at the receiving station; the dropping [illegible] indicates the station from which the call has come, and [illegible] the particular pipe to be spoken through. It is found that [illegible] voice pipes communication to places where there is [illegible] tion or noise is not very satisfactory. Many devices have [illegible] and are still being tried with the object of improvement. The committee were much impressed with the immense [illegible] offered by an electrical system of communication, and, [illegible] other things, telephones of different forms were tried [illegible] tion for voice pipes. The results were not such as to lead to their introduction into the ships of the navy.

Telegraphs.—With regard to instruments, though for ships [illegible] a mechanical system has some great advantages over an electrical, yet as a means of establishing communication between [illegible] instruments at distant stations the electrical system is [illegible] away the best. The many disadvantages of a system of [illegible] and bevel wheels, led through a considerable portion of the [illegible] of a ship, scarcely need to be stated, while the great [illegible] offered by a simple insulated wire are equally self-evident. The committee therefore recommended that the one mechanical telegraph for communicating orders from the bridge or [illegible] tower to the engine room should be retained, but that the telegraph for orders respecting speed of revolution should be electrical. Many of these electrical telegraphs have been [illegible] the navy; but the reports upon them have not been [illegible] favourable, although in some instances they have been [illegible]. Whether the grounds for the unfavourable reports have [illegible] been good and sufficient is a matter of opinion; but at the [illegible] time electrical telegraphs in the navy appear to be [illegible] under a cloud, so that the field is still open for inventors [illegible] direction. The telegraphs already in use are worked by [illegible] or secondary batteries, while a new form has been proposed [illegible] be worked direct from the ship's dynamo.

5. Other Applications of Electricity.

Submarine Mines.—There are some other applications of electricity in the naval service which may be referred to [illegible] detailed descriptions. One important application is that [illegible] marine mining, whereby stationary torpedoes or mines are [illegible] by an electrical current from an observing station on shore [illegible] the position of an enemy's ship in relation to the mines [illegible] ascertained by means of range-finding instruments in [illegible] stations at a considerable distance apart but electrically [illegible]

An electrical apparatus has also been designed and experimented with for enabling a boat, without any person [illegible] sent from a safe distance into an enemy's mine field, to [illegible] and thus render harmless the mines laid there. By [illegible] the boat can be steered, the engines stopped or started, and [illegible]

countermines dropped when desired and exploded. In this way an otherwise exceedingly risky operation can be performed without danger to life; and the worst casualty that can happen is the loss of the boat only.

Night Signalling.—Electricity is also applied to night signalling. The ordinary semaphore instrument as used by day is illuminated at night by means of incandescent lamps in front of a reflector, the whole being contained in a wooden box placed at a short distance in front of the semaphore arms, which are painted white, in order to make them more distinctly visible by night in the rays of the electric lamps. Another system of night signalling has lately been introduced, consisting of four flashing lamps placed in a vertical line at topmast head. The lamps are incandescent with special filaments, and one lamp or more can be switched off at will by an arrangement of switches in the chart-house, where there are also four small lamps which follow the movement of the lamps at masthead. By a preconcerted code the combinations of the lamps are interpreted. This arrangement is intended principally for squadron sailing at night, to convey orders as to altering course, speed, etc.

Gun Sights.—The sights for guns are now adapted for night firing by employing electricity for their illumination. This is effected by means of small incandescent lamps, for which the current is obtained from a primary battery consisting of three Leclanché cells in a box secured to some part of the gun mounting. A switch is also fitted for each sight, having a resistance connected with it, so that the current can be varied at will, and thus the lights can be made more or less brilliant to suit circumstances.

Examination of Gun Bores.—An apparatus is now supplied to ships for examining the bores of guns. It consists of an inclined mirror supported in a metal frame, which is made to fit the bore, and can be pushed into any part of the bore by a long rod screwed into it. According to the size of the gun the frame carries from one to four 100-c.p. lamps, which illuminate the bore; and by the aid of the inclined mirror a close examination can be made for defects.

Motors.—The application of electricity to motors has not yet gone very far, not so far, in fact, as in some other nations it has already gone or is now going. Of the success of its application to the working of guns, supply of ammunition, etc., the writer is not very sanguine; but if results prove satisfactory, the navy will no doubt quickly profit by the experience of other nations. Electrical science is as yet in its infancy, and it promises enormous developments in the near future; so that in a few years operations may be performed by electricity which are not dreamt of now. In any case the British Navy will not fail to press into its service every development of science which will increase the efficiency of the nation's first line of defence.

COMPANIES' MEETINGS.

EASTERN TELEGRAPH COMPANY.

The half yearly general meeting of this Company was held on Friday last at Winchester House.

Sir John Pender, M.P., who presided, stated that the gross revenue for the half-year ended March 31 last had been £382,207, being a decrease of £1,100 compared with the revenue of the corresponding period of the previous year. The small decrease of £799 in the message receipts was principally caused by the loss of revenue from the reduction of the Australian tariff, and by small decreases in the receipts from other sources, notably South Africa, but these reductions had been almost counterbalanced by the growth of traffic in other directions. The total ordinary expenses for the half-year ended March 31 last had been £105,820, or an increase over those of the corresponding period of 1891 of £3,800, of which £3,692 represented the increase in the working expenses at the stations, which had amounted in the half-year under review to £78,695. The number of messages carried by them in 1891 was 1,309,755, or an increase over the number carried in 1890 of 123,387. Important improvements had been effected at several of the stations, and owing to their good condition they had considerably below the average of cases of disease. Their ships had been fully employed carrying out important works of repairs and renewals, not only on the Company's account, but also on account of the Brazilian, the South African, the African Direct, and the Direct Spanish companies. The money accruing from these repairs had given the Company about £15,000. They were able to propose the usual final dividend of 1¼ per cent., with a bonus of 1¼ per cent., making, with the interim dividends already paid, a total distribution of 6¼ per cent. for the year ended March 31, 1892, and to carry £68,000 to the reserve fund. After applying from this fund a further sum of £72,773 towards the cost of the Aden Bombay triplicate cable and other expenditure, the general reserve fund would amount to £442,014, and the total amount applied from this fund for new cables, etc., now amounted to £1,174,236. At the last meeting the shareholders approved the principle of establishing a staff pension fund, and the Directors had had a scheme prepared by experienced actuaries, who had advised that an annual contribution by the Company of 2½ per cent. on the salaries and a similar contribution by the staff would, if invested at 4 per cent. compound interest, provide sufficient funds to make adequate retiring allowances for the younger members of the staff on their attaining 60 years of age. As many of the older employés, however, had already seen considerable service, and their retirement in some cases could not be far distant, 2½ per cent. would be insufficient to place them on an equally favourable footing. With a view, therefore, to supplementing their allowances from the pension fund, the actuaries advised that, in addition to the 2½ per cent. just referred to, the Company should continue the present contribution to the endowment assurance fund in full until all the existing policies were paid off, and allow the savings effected by the premiums ceasing to be payable to the assurance company, as the policies matured from time to time, to be applied exclusively for the benefit of the older servants. The wish that the older servants should not be placed on a less favourable footing than the younger members of the staff was strongly expressed at the last meeting. The actuaries further recommended that the Company should guarantee 4 per cent. interest on the accumulations of the fund. Provision was also made in the actuarial calculations for dealing with cases of death or breaking down in health before reaching the retiring age and for other contingencies. This was a fair outline of the actuaries' scheme, but as certain details were under consideration by the Board it was proposed to ask the shareholders to approve a resolution in general terms empowering the Directors to bring the scheme into operation when the details were finally settled. He concluded by moving the adoption of the report and the payment of the dividends and bonus recommended.

The **Marquis of Tweeddale** (the vice-chairman) seconded the motion

In answer to **Mr. Sears**, the **Chairman** stated that the proposed staff pension fund would cost the Company about £2,000 a year more than they had been paying on a similar account for the last five or six years.

The motion was adopted, and a resolution was afterwards passed, on the motion of the **Chairman**, seconded by **Sir James Anderson** (the managing director), approving the establishment of the staff pension fund and authorising the Directors to carry the scheme into effect with such alterations and modifications, if any, as might be approved by them.

Replying to a vote of thanks to the Chairman and Directors, the **Chairman** expressed his gratification at the remarks which had been made congratulating him on his return to Parliament. He had had 50 years of active life, and it might be thought rash on his part to have sought being returned to Parliament again. Of course, they had no politics as a Company, but he might state that, even at his time of life, he did not want to see anything done to weaken the Empire, and he would do his utmost while any life remained in him to maintain it.

WEST AFRICAN TELEGRAPH COMPANY.

The seventh ordinary general meeting of this Company was held last Friday, at Winchester House, Old Broad-street, Sir J. Pender, chairman of the Board of Directors, presiding.

The **Chairman** said their revenue for the year 1891 amounted to £60,214, as against the takings of 1890 of £68,377, showing a decrease of £8,163. There was a decrease in the Cape joint purse and the traffic with the French stations, but this was nearly counterbalanced by increase in traffic with British and Portuguese stations, with South America, and local traffic. The principal cause of the reduction of the revenue was the serious depreciation of the Portuguese currency. As would be seen from the accounts, there had been a total loss on exchange of £7,011, nearly the whole of which was due to loss on remittances between Portugal and England. This matter had received the serious consideration of the Directors, and negotiations were pending with a view to a satisfactory settlement. They had been endeavouring to obtain the consent of the Portuguese Government to raise their rates of collection on the West Coast, and the suggestion had been favourably received, and should the change be formally sanctioned it would to a certain extent minimise the loss on the rate of exchange Fortunately, the money collected in Portuguese currency on the coast had been used for general expenses at the various stations, and the Company this year saved £2,700 loss, which would have been incurred had the money been remitted to London. The total working expenses for 1891 amounted to £20,883, against £21,685, or a decrease of £802. Several of the items showed an increase, and others a decrease, under the headings of "working expenses at stations," which were less than last year by £394, and "repairs to cables" £2,213, against £4,788, or a decrease of £2,575. The balance available for dividend and reserve fund was £12,639, against £17,570, or a decrease of £4,931. It was proposed, therefore, to pay a final dividend of only 2¼ per cent., making, with the interim dividend already paid, a total distribution of 4 per cent. for the year, and to carry the balance of £3,395 to the general reserve fund, which amounted to £30,363. The real question at the present moment was this question of exchange. He could not hold out very much hope of Portuguese finance improving greatly, but he thought they might, by raising the rate of collection, save themselves from the very serious loss which they were now sustaining. There was another feature in their business which he should like to mention, and that was that there had been a general depression over Africa. The Cape, as they all knew, had had its time of trials and depression, and they were passing through a phase of depression at the present time; but there was so much vitality in the country that he had no hesitation in coming to the conclusion that prosperity would return, which would give the Company increased revenue and profit. Altogether, while he might say that although the report was not very satisfactory, it was not very unsatisfactory, and taking the "ups and downs" which always occurred at the beginning of a telegraph system which had more or less to be nursed and developed, he thought the prospects for them in the future were

upon the whole very favourable indeed. He might add that they did not possess the healthiest stations for working this system of telegraphy, and therefore they had to be particularly careful in seeing that their staff at the stations were well looked after. They gave them comfortable homes, and did everything they could to ameliorate the conditions of the climate, and they were fully satisfied in doing so that they were not only benefiting the Company's agents, but securing for themselves a class of workers better than they could do under other circumstances. In conclusion, he moved that the report and accounts be adopted, and the dividend declared payable.

The motion was seconded by **Sir H. Mance**, and unanimously agreed to.

Sir J. Pender and Mr. R. J. Gray, the retiring directors, were re-elected.

UNITED RIVER PLATE TELEPHONE COMPANY.

The sixth annual ordinary general meeting of this Company was held on Tuesday at Winchester House.

Mr J Irving Courtenay, who presided, in moving the adoption of the report, referred to the extremely critical period which this Company, in common with all others in the River Plate, had had to pass through during the past 12 months. Though it might be considered rash to attempt a forecast, still, he strongly inclined to the opinion that matters, both financial and political, in the River Plate had seen their worst. The gross income from the River Plate for the period under review was £98,690, against £106,259 in the previous year. This difference was, to some extent, caused by a falling off in their subscribers between March, 1891, and the same month this year; but he might say it was mainly due to their writing off over £5,000 for subscriptions which their Buenos Ayres managers had recommended. Some of these might yet be recovered. Notwithstanding the economies that had been effected, their expenses in the River Plate had slightly increased. The principal cause for this was the augmented cost of materials and other necessaries requisite for carrying on the ordinary business of the Company. The loss on exchange for the year ended March 31 last was £31,741, an amount nearly representing 11 per cent. on the Company's paid-up share capital. The gross receipts amounted to, say, £98,700 and the whole of their expenditure in the River Plate was, in round figures, £58,000, thus leaving a profit in paper dollars, the par value of which was £40,100. They were compelled to remit this profit home to pay debenture interest and other expenses in sterling, and in so doing they lost on exchange £31,700, which left them a balance when received in London of £8,400 to meet these expenses. In the London outlay they had made a considerable reduction. They thought that the working for the current year would be much more satisfactory than it had been for the previous 12 months, because of a substantial increase in the number of subscribers and the fall of the gold premium from an average of 280 to 223 per cent. The capital outlay for the year had been extremely small—£1,008. At the same time their plant had been well kept up. At Rosario, in consequence of the introduction of the electric light, special appliances had been provided to guard against any damage resulting from contacts.

Mr F W Jones seconded the motion, which was carried.

GLOBE TELEGRAPH AND TRUST COMPANY, LIMITED.

The nineteenth ordinary general meeting of this Company was held at Winchester House.

Sir John Pender M P, who presided, stated that for the year ending the 18th inst. their receipts showed a decrease, as compared with those of the previous year, of £9,455, after paying expenses. They had received £2,184 less on their investment in the Anglo-American Company, £3,823 less from the Brazilian Submarine Company, and no dividend from the German Norwegian Company. They had also received somewhat smaller dividends from the West African and the Western and Brazilian Companies, the diminution together amounting to about £1,000. Nevertheless, the sum they were able to divide was only £7,697 smaller, owing to the large balance brought forward in 1891. They had a dividend to recommend on the present occasion of 1½ per cent. for this year, compared with 5¼ per cent. for the previous year. Their preference and ordinary shares, taken in like amounts, showed a return of £5. 8s. 9d. per cent. The money reinvested in the West Coast of America Company had so far given no return, but the prospects of dividend from this source were very promising. A line was now being constructed across the Andes which would bring the Brazilian Submarine Company into communication with the Pacific coast, and they then expected to see a considerable increase of traffic, not only for the Western and Brazilian Company, but also for the West Coast of America line. The Brazilian Submarine Company had paid them £4,000 less than they did in the previous year. That company was building up its reserve fund, but they hoped it would soon return to its former dividend. The dividend, however, which they at present received from the Brazilian Submarine Company was equal to a return on this investment over 7 per cent. They had a large amount of capital in the Eastern and Eastern Extension Companies, which showed good returns, yielding together a dividend to the Globe Company of over 6½ per cent. Their shares in the American Cable Company gave them a return of 5¼ per cent., and their Western Union shares yielded them £5. 17s. 5d. per cent. and had improved in value. With the general growth of telegraphy—and telegraphy must grow—their dividend would improve. After referring with regret to the death of the late secretary, Mr. William Payton, and of Mr. William Ford, a former member of the Board, he concluded by moving the adoption of the report.

The **Marquis of Tweeddale** seconded the resolution, which was unanimously carried.

COMPANIES' REPORTS.

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald Lodge, Stanmore; Charles Seymour Grenfell, Esq., [illegible], Taplow; Sampson Hanbury, Esq., Langford Park, Maldon, [illegible] S. Barclay Howard, Esq., Hatfields, Loughton, Essex; [illegible] Tate, Esq., 21, Mincing-lane, London, E.C.

Report of the Directors for the half-year ending June 30, 1892, to be submitted to the half-yearly ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on Friday, August 5, at 3 p.m.

The receipts during the half-year from all sources amounted to £21,520 4s. 8d., and the cost of working for that period to £15,097 13s. 2d., leaving a profit of £6,422 11s. 6d. Including the balance brought forward from last year, the net revenue account shows a total of £7,348 19s. 9d. After providing the debenture interest amounting to £1,317 7s. 4d., there remains a balance available for dividend of £3,031 12s. 5d., out of which your Directors recommend that the full dividend of 5 per cent. per annum be paid on the perpetual preference shares, and they further recommend that a dividend at the rate of ½ per cent. per annum be paid on the ordinary shares, leaving a balance of £983 2s. 2d. to be carried forward to the next account. The number of passengers carried by the railway during the six months, exclusive of season ticket holders, was 2,813,162, showing an increase over the corresponding period last year of 400,819. The steady decrease in the expenses alluded to in previous reports has been satisfactorily maintained, notwithstanding a considerable further increase in the [illegible] paid for rates and taxes. The rolling stock and plant have been efficiently maintained, and are in good working order. The fourth generating engine and dynamo are erected [illegible] for use. Arrangements have recently been made by which the public are allowed to view the generating station on payment of a small charge, and this privilege is being availed of to a considerable extent. During the past session a Joint Committee of the two Houses of Parliament was appointed to consider and report upon the best method of dealing with the various electric and cable railway schemes in the Metropolis proposed to be sanctioned by Parliament. They reported strongly in favour of electricity as a motive power, and made some valuable suggestions for the extension of railways of this character. The successful working of this line had no doubt great influence in inducing the committee to make so favourable a report. Owing to the dissolution of Parliament, the Bill promoted by this Company for the extension to Islington and other purposes could not be proceeded with further than the second reading in the House of Commons. The Directors therefore decided to take advantage of the resolution passed by both Houses by which all private bills are carried over to next session, when they will be proceeded with at their present stage. The urgent need of additional [illegible] accommodation at Stockwell Station to meet the requirements of growing traffic renders it desirable that this work should not longer be delayed. To meet this expenditure it will be necessary to issue some additional preference shares. A resolution to that effect will be submitted at the special meeting. Your Directors being of opinion that the time has now arrived when the present terminable debenture mortgage bonds should be converted into perpetual mortgage stock, propose to ask the shareholders for authority to carry this out, and a resolution will be submitted at the special meeting for the issue and creation of debenture stock to the extent of the authorised borrowing powers of the Company. It is hoped that a considerable saving in the interest charges will be effected by the operation. Your Directors have to announce with great regret the death of Major Kitson, who has been one of the auditors since the commencement of the railway. Notice has been received from a large shareholder of his intention to propose Mr. James [illegible] Oliver to fill the vacancy thus created.

CROMPTON AND CO., LIMITED.

Directors: H. H. J. W. Drummond, Esq.; Bernard [illegible], Esq.; Viscount Emlyn; Carleton F. Tufnell, Esq. Managing Directors: Rookes Evelyn Bell Crompton, Esq., and John Francis Albright, Esq.

Fourth report of the Directors, to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon-street, E.C., on Friday, the 29th July, 1892, at 2.30 p.m.

The Directors have pleasure in submitting to the shareholders the fourth annual statement of accounts and balance-sheet made up to the 31st March last, to report that the business of the Company continues satisfactory, and that the reorganisation and additions to the Chelmsford works have proved a great advantage in increasing the output and reducing the cost of manufacture. In order more effectually to separate the account for the electric lighting of Chelmsford from the manufacturing and other accounts of the business, the Directors have caused to be registered the Chelmsford Electric Lighting Company, Limited, to which company the

general meeting early next year to place the Company in voluntary liquidation, and to authorise the distribution of the capital."

Anglo-American Telegraph.—The report of the Directors states that the total receipts from January 1 to June 30, including the balance of £864 brought forward from last account, amounted to £147,818. This sum, however, is subject to revision, as the law suit between this Company and the Paris and New York Telegraph Company is still pending before the Court of Appeal in Paris. The traffic receipts show an increase of £10,035 as compared with the corresponding period of last year. The total expenses of the half year, including the repair of cables, etc., amounted to £59,364. One quarterly interim dividend of 12s. 6d. per cent. on the ordinary stock and of £1 5s. per cent. on the preferred stock was paid on April 30, absorbing £43,750, and a second quarterly dividend at the same rates will be paid on July 30, leaving a balance of £954 to be carried forward to the next account.

New Telephone Company.—Messrs. N. M. Rothschild and Sons are authorised on behalf of the New Telephone Company, Limited, to receive subscriptions for 48,800 ordinary shares of the Company of £10 each at par. The Company was formed in 1885 with a nominal capital of £750,000 divided into 74,700 ordinary shares of £10 each and 3,000 founders' shares of £1 each, the latter entitled to one half of the surplus profits after the payment of a dividend of 7 per cent. on the ordinary shares. Of the 74,700 ordinary shares, 1,500 were issued on the formation of the Company, and the present issue is for the balance—73,200 shares—of which one third is to be subscribed for at par by the National Telephone Company, Limited. The New Telephone Company is the possessor of a license granted by the Postmaster-General for the establishment of telephone exchanges and communications in the metropolis and throughout the United Kingdom, but the Company has been unable to develop its undertaking until the Telegraphs Act of 1892, which received the Royal assent on June 28 last, placed it in a position to deal satisfactorily with the telephonic requirements of the country.

London County Council. The Council met on Tuesday at Spring gardens, when the following tenders were received for the electric lighting of Claybury Asylum (contract No. 1).

Woodhouse and Rawson	£13 970
F. M. Newton	14 105
Latimer Clark, Muirhead, and Co., Limited	15 130
Brush Electrical Engineering Company, Limited	15 800
Appleton, Burbey, and Williamson	16 500
J. E. H. Gordon and Co., Limited	17 337
Crompton and Co., Limited	17 500
Edmundsons, Limited	17 737
J. G. Statter and Co.	18 128
Sharpe and Kent	18 540
Bourne and Grant	18 808
Manchester Edison Swan Company, Limited	18 850
Johnson and Phillips	19 200
Mather and Platt, Limited	19 250
Hammond and Co.	19 900
Electric Construction Corporation, Limited	19 932
Drake and Gorham	20,500
Fowler, Lancaster, and Co., Limited	20 549
J. D. F. Andrews and Co.	21 000
Paterson and Cooper	22 540
Rogers' Electrical Engineering Company, Limited	23 966
R. Verity and Sons	26 471
Laing, Wharton, and Down	27 982
Siemens Bros. and Co., Limited	28 400

The tenders were referred to the Asylums Committee.—*Contract Journal.*

PROVISIONAL PATENTS, 1892.

JULY 18.

13,134. **An improved form of voltmeter.** Francis Henry Nalder, Herbert Nalder, Charles William Scott Crawley, and Alfred Soames, 16, Red Lion street, Clerkenwell, London.

13,146. **Improvements in microphones.** Sir Charles Stewart Forbes, Bart., 21, Finsbury pavement, London.

JULY 19.

13,160. **Increasing the efficiency of telephonic communication and transmitting speech.** Thomas Oddy, River street, Rochdale.

13,167. **Electric arc lamp.** William Edwin Irish, 36, Chancery lane, London. (Complete specification.)

13,207. **Improvements in incandescent electric lamps.** Louis Stein, 17, Southampton buildings, Chancery lane, London.

13,218. **A process for covering or insulating submarine cables and underground installations and other purposes.** Tom Sumner Lemon, 35, Sebert road, Forest Gate, London.

13,221. **Improvements in or connected with telephones.** Wilhelm Deckert, 4, South street, Finsbury, London. (Complete specification.)

JULY 20.

13,288. **Improvements in connections for electroliers and other electric light fittings.** Hugo Hirst, 11, Furnival street, London.

JULY 21.

13,323. **Improvements in or connected with the production of electric energy.** Henry Clay Bull and George Bell Cowl, 15, Water-street, Liverpool.

13,335. **Improved means for signalling by electricity on [illegible] ways.** Thomas Whittingham, 128, Colmore row, [Bir]mingham.

13,337. **Improvements in electric belts which impro[ve] ... are also applicable to other purposes.** George [illegible] Harness, 20, High Holborn, London.

13,338. **An improved switchboard.** Sir Charles Stewart [Forbes,] Bart., 21, Finsbury pavement, London.

13,358. **Improvements in or relating to alternate[-current] circuits.** William Morris Mordey, 46, Linco[ln's Inn] Fields, London.

13,375. **Improvements in or relating to electric meters, [measur]ing apparatus, and controlling gear.** Wilfrid L. [illegible] The Elms, Seymour grove, Manchester.

13,380. **Improved means of preventing injury to te[legraph] cables connected with lightships and floating [illegible]** Frederick Le Breton Bedwell, 166, Fleet street, Lo[ndon].

JULY 22.

13,381. **Improvements in the manufacture of electrical [illegible] plates, cells, or accumulators and the acc[essories] thereto.** Edward Brailsford Bright and Lewis [illegible] Mercier, Archway House, Esher, Surrey.

13,389. **Improvements in voltmeters.** Frederick Bro[illegible] Bridge street, Walsall.

13,395. **Improvements in or relating to electrical ap[paratus] for signalling.** Maunsell Mercier, 5, Deansgate, [Man]chester.

13,405. **Improvements in portable Leclanche batteries.** [illegible] Nehmer, 4, Grafton street, Gower street, London.

JULY 23.

13,453. **Improvements in electrodes for use in elec[trical] apparatus, and in their manufacture.** Godfrey [illegible] 17, Holborn, London.

13,473. **Improvements in apparatus for heating purpo[ses and] cooking by means of electricity.** Gustav [illegible] 11, Furnival street, London.

SPECIFICATIONS PUBLISHED.

1891.

6,072. **Electro heating apparatus.** Carpenter. (Second [edition.])

11,108. **Electric batteries.** Coad.

11,526. **Electric lamps.** Adams.

11,548. **Conductors for electric propulsion on perman[ent way].** Prokofiew.

11,630. **Ribbed metallic plates for secondary batteries.** [illegible]

13,124. **Heating and welding by electricity.** Howard. [(Second] edition.)

14,097. **Telephone transmitters.** H. L. and J. Todd.

14,236. **Generating and distributing electricity.** L[illegible] Pritchett.

14,266. **Administering electricity to horses.** M. and [illegible] Humm.

14,508. **Arc lamp.** Warburton.

15,483. **Electric lighting.** Mewburn. (Sec.)

17,426. **Generating ozone by electricity.** Andreoli.

1892.

785. **Incandescent electric lamps, etc.** Ries.

4,910. **Telephone apparatus.** Lockwood.

4,617. **Electrical attachments for pianos.** Feldkamp and [illegible]

9,056. **Electrically giving reciprocating motion.** McKa[y.]

9,379. **Electrically heating and working metal bars.** [illegible]

9,409. **Electromagnets for organs, etc.** Binns.

9,815. **Foot supports for telegraph poles, etc.** Stocker.

9,883. **Electric motors.** Thompson. (Collan.)

9,947. **Electric conducting wires.** Haddan. (Grammont.)

9,983. **Propelling railway vehicles by electricity.** T[illegible] (Ries and another.)

10,133. **Electrical insulators.** Brandau.

10,230. **Electric condenser.** Lord Kelvin.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid
Brush Co.	[illegible]
— Pref.	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10
House to House	5
Metropolitan Electric Supply	[illegible]
London Electric Supply	[illegible]
Swan United	[illegible]
St. James'	—
National Telephone	[illegible]
Electric Construction	[illegible]
Westminster Electric	[illegible]
Liverpool Electric Supply	[illegible]

NOTES.

Tonbridge.—Electric communication is to be put in the new hospital of the Tonbridge Board of Guardians.

Telephone Patents.—The Belgian Bell Telephone Company has gained its suit against the English Edison Company.

Tommasi Accumulators.—A company has been formed in Paris to manufacture Tommasi's multitubular accumulators.

Zurich.—A 400-h.p. station is being erected at Macerata, says *Industries*, by Messrs. Escher, Wyss, and Co., and the Oerlikon Company.

Limburg, on the Rhine, celebrated for its strong cheese, is to have a Lahmeyer central station, with power transmitted a mile from the River Lahn.

Sherborne.—A horse and carriage show is being held at Sherborne, commencing yesterday. Mr. E. R. Dale is exhibiting electric cycle and carriage lamps.

Book Received. — We have received from Messrs. Spon the second edition, thoroughly revised, of "The Electrical Engineer's Pocket-Book," by Mr. H. R. Kempe.

Asylum.—The great asylum at Wadsley, near Sheffield, is to be extended. This is a building where electric light would be efficacious. It is under the West Riding County Council.

Eccles.—At the last meeting of the Eccles Local Board, a committee was formed to take the necessary steps to obtain a provisional order for supply of electric light in the district.

Crystal Palace School.—Mr. Latimer Clark will take the chair at the award of certificates of the Crystal Palace School of Practical Engineering in the Palace on Saturday, at 1 p.m.

Croydon.—The Croydon Town Council have received an offer from a company to take over their provisional order, but do not feel disposed to let their powers for electric lighting go out of their own hands.

Use of Destructors.—At the British Association Prof. Forbes read an interesting paper on the use of destructors in conjunction with high-level water accumulators, especially connected with the lighting of Edinburgh.

Baden Railway.—The German Minister of Commerce has been asked to sanction the conversion of the Baden steam tramway to an electric tramway. It is proposed to extend the line to Vöslau, and use the power station to line the town.

Chadwell Heath.—The Barking Gas Works has the right of supplying gas to this district, but it is rather out of the way, and so gas cannot be obtained. Some suggestions have been made for public or private enterprise to introduce the electric light.

Barnsley.—Mr. J. C. Stott, in the Barnsley local paper, objects to the Corporation having 10 times the present light, as they propose. He thinks one and all agree Barnsley is now thoroughly well lighted. Fortunately, the Council do not agree to this.

Journal.—We have received the *Journal* of the Institution of Electrical Engineers, containing paper and discussion on the "Newcastle Electric Supply," by A. W. Heaviside and R. C. Jackson, and on "Commercial Electrolysis," by Jas. Swinburne.

Bournemouth Tramways.—The Bournemouth and Poole Tramways Company have had the time authorised for commencement of work extended to two years from August 4, 1892. We believe an attempt is to be made to run them by electricity, as electricity is already in favour in the town.

Wigan.—A circular from the town clerk of Wigan was read at the meeting of the workhouse authorities asking if the Board were desirous of being supplied with the electric light. It was decided to answer the communication in the negative. Electric light is yet too much of a luxury to be applied to workhouses.

Free Telephones.—The National Telephone Company are acting on a generous and spirited policy by giving free connections at Cheltenham to the Children's Hospital, the General Hospital, the District Nursing Society, the Eye, Ear, and Throat Infirmary, the Gordon Boys' Brigade, the Fire Brigade Station, and the Police Office.

Electric Traction.—The *Street Railway Gazette* is responsible for the statement that of the 400 street railroads in the United States, more than half have adopted electricity as motive power. In no other industry—except perhaps corn-milling on the introduction of the roller system—has such a radical and extensive transformation taken place in so short a time.

City Guilds College.—We are pleased to call attention to the notice of the classes at the City and Guilds of London Institute, which commence at the end of September. We have often expressed our opinion on the usefulness of these institutions, and a two years' course, followed by practice in the shops, will enable a sensible, painstaking student to qualify himself for a career as a practical scientific man.

Niagara.—We have good authority to state that the reported offer to Prof. Unwin to accept the position of chief engineer to the Niagara transmission scheme at over £5,000 a year is perfectly true. It is equally true that he has refused this tempting offer (which would have placed him certainly at the head of the practical engineers at one bound), preferring to remain at the Central Institution and continue his educational work there.

Southend.—The Southend Pier is to have a telephone. A report has been received from Messrs. Crompton with reference to the electric appliances on the pier. The Board of Trade circular with reference to the electric lighting order elicited the information from the chairman of the Local Board that the provisional order was not yet in danger of running out. The tender of Messrs. Crompton, at £18. 16s., for connections to old trams was accepted.

Loss of a Dynamo.—Mr. Alfred Crofts, of St. James-street, Dover, says that at the close of the Electrical Exhibition, Crystal Palace, one of his exhibits—a small unwound dynamo at 208, South Gallery—after being packed, mysteriously disappeared, and the efforts of the Crystal Palace staff have failed to trace it. As it may have accidentally been taken in mistake with some other exhibitor's packages, this notification of the loss may assist in finding the errant machine.

Heckmondwike.—At the meeting of the Heckmondwike Board of Health last week, the Electric Lighting Committee sent in a modified recommendation "that the Board be recommended to consider the propriety of lighting the town by electricity," instead of, as before, that they "should put down the necessary plant" at once. But Mr. S. Wood gave notice that he would move a resolution at the next meeting authorising the Board to put down the necessary plant.

Portsmouth.—Tenders will be invited for the Corporation central electric station at Portsmouth before very long. The building contracts will be, of course, required first, but the engineering and electrical tenders will not be far behind. Mr. Manville, the consulting engineer to the

Portsmouth Corporation, has been busy for some time on the detailed plans, and the sanction of the Local Government Board for power to borrow is expected shortly The system, it will be remembered, is that of the high-tension alternating current with sub-transformer stations under the streets.

Cyclists' Camp. — The great cyclists' meeting at Dorking which is being held this week, is enlivened at night by the electric light. The Hammersmith club have a practical man or two, apparently, in their ranks. They took down a dynamo and an old engine obtained from somewhere, and started the light—or rather didn't start it, for the engine fell to pieces, or at least would not work. Then there was a hunt all over the district for steam power, and a traction engine was at last requisitioned. The light then went well and steadily, and the scene, with the Sultan of Morocco and other fancy dresses of the merry cyclists, was a grand and enchanting spectacle.

Bacup.—At the monthly meeting of the Bacup Town Council last week, the town clerk reported that he had sent out 194 circulars to millowners, tradesmen, and others with a view to ascertaining whether they were willing to take the electric light; 44 answers had been received, representing about 500 gas lights, in which the major portion expressed their willingness to adopt electricity in lieu of gas, provided the charge did not exceed 6d. per unit. The Council considered the result unsatisfactory, and instructed the town clerk to communicate with the parliamentary agents with a view to securing an extension of the Corporation's provisional order, 1890.

Associated Chambers of Commerce.—An interesting occasion for meeting on business and pleasure will be the visit of the Associated Chambers of Commerce to Newport during the week beginning September 19th next. Sir Albert K. Rollit, M.P., will be chairman. A business session and inspection to the docks will occupy the first two days, and the last three will include excursions, amongst which will be a visit to the famous Risca and Abercarn Collieries, which are electrically fitted. The works of the Ebbw Company, the Crumlin Viaduct, Tintern, and Monmouth will also be visited. On Saturday an exploration of the available land for the wharves and docks on the River Usk will be made, and the harbour and port of Newport will also be inspected.

Coast Communication.—In commencement of the system of establishing telegraphic and telephonic communication around the British coast the telegraph steamer "Monarch," with Lieutenant Williams, R.N., and Mr. Lumsden, the electrician, on board, arrived at Scilly on Tuesday afternoon, and on Wednesday commenced the work of connecting the coastguard stations at St. Mary's, St. Agnes, Bryher, Tresco, and St. Martin's. Before darkness set in they had laid a submarine cable from Bryher to Tresco, and from the Cove at St. Agnes to about half way to Porthcressa Beach at St. Mary's, where they have buoyed the end of the cable for the night Operations were resumed next day. This communication will be of the greatest value for conveying news of wrecks to the lifeboat stations at night or during the prevalence of fogs.

Brighton.—We are glad to learn that the central station is being well supported, installations being added with great freeness. We are not so pleased to hear (except from the point of view that it shows extension) that it will be necessary to reopen the streets for the addition of a third cable to convert it at this stage to a three-wire system. Moreover, whatever else is lighted, one would think that the esplanade and pier should have electric light, yet none is seen. A recent view in the illustrated papers showed gas burners in full force, and this view is used, we see, even now as an advertisement of Sugg's burners. Brighton, the richest watering place in the South, and no public electric light! It is hardly believable. The rate of charge for the current is 7d. a unit, and not much is yet done with day load—we hope some motors will be got to work to fill up the load.

Dublin.—The Dublin Corporation, last Friday, had before them the question of handing over the electric light station to the contractors to carry on, and the duration of the appointment of electrical engineer. After being amended to include reference to their lawyer, the Council adopted the amended resolution, as follows: "That the report of the Electric Lighting Committee be adopted with the addition, that instead of being compelled to accept the tender of Messrs. Hammond and Co., the committee shall have power, if they see fit, under the advice of their law agent, to enter into a contract for running the station, and consenting to any extension of it, for one year, with Messrs. Hammond and Co.; with any other contractor or contractors; or if they see fit the committee may undertake to carry out the running of the station themselves, employ workmen, purchase materials, and do all that is necessary in the matter; and that the employment of Mr. Ruddle be for 12 months only."

Cathedral and Church Lighting.—St. Mary's Roman Catholic Cathedral at Newcastle-on-Tyne was reopened on Sunday by the Very Reverend John Vaughan, of Westminster, and in the evening was lighted for the first time by the electric light. We understand that this is the only Roman Catholic cathedral, except St. Sylvester's in Rome and one in France, which is so lit. The installation has been fitted by Messrs. R. J. Charleton and Co., of Newcastle-on-Tyne. We have recently mentioned the case of a church being lighted from a mansion. A similar installation has also just been carried out by the above firm at Prudhoe Hall, near Newcastle-on-Tyne, in connection with which there is a Roman Catholic church. The number of lights at Prudhoe, including the mansion of Mrs. Liddell, the stables, outhouses, etc., and the church adjoining, is equal to about 280 16-c.p. lamps. The power here is obtained from a steam engine and large Lancashire boiler. There are two batteries of E.P.S. cells, 31 L type, and the fittings inside the house are very handsome. The installation has given much satisfaction to all concerned.

Carlow.—A communication from Messrs. J. E. H. Gordon and Co. was before the Carlow Town Commissioners at their last meeting, asking that the time for which they should have the exclusive lighting of the town should be extended from 21 to 42 years. This was in view of the intention of Messrs. Gordon to erect steam engines for the perfection of the present system of lighting at considerable expense. To this request the Commissioners replied asking if the company would, within 10 years, have the wires put underground instead of overhead. Messrs. Gordon, however, wrote saying it was impossible to give this guarantee. The chairman and others were in favour of giving the extension in consideration of the expense incurred, though Mr. Shackleton said he did not care to hand over the town for 42 years. The chairman said they had now obtained an excellent system of electric lighting, and as a result of it they had directly caused the gas company to make three reductions in the price of gas amounting in all to 1s. 6d. in 1,000ft. Mr. Johnson proposed that the time be extended to 42 years, and this resolution was passed.

Taunton.—So Taunton has come safely through the crisis, and has adopted the scheme for purchasing an-

altering the present installation to possess their own central station. Everyone will be pleased to hear that the town which has done so much for the spread of electric lighting has carried out this resolution. A special meeting was held on Tuesday, the Mayor, Alderman Chapman, presiding, when the Electric Lighting Committee presented a report, which is given elsewhere, in which they recommended that the amount necessary be raised by borrowing for a period of 50 years, or such other period as the Local Government Board would grant. The amount which it is proposed to expend is £14,000. Of this £9,300 will be devoted to the purchase of the works in the manner recommended in the second report of Mr. G. Kapp, while £1,900 will be expended in the substitution of underground for overhead wires, with the addition of seven new lamps; £1,000 of the total will be set apart as working capital. The Council adopted this report. It was formally agreed to apply to the Board of Trade for a license, and the Mayor signed a memorial to that effect.

Horse Racing by Electric Light. — We have recounted how electric horse-racing is carried out by wooden horses driven by electric motors in France, but at St. Louis they have the real thing by electric light, and according to the *Daily News*, it has been a great success. The course at South Side Park presents a curious appearance—the stand, fences, posts, and everything paintable about it being of dazzling whiteness. In the glow of the bright lights, the effect is very striking. At a height of 20ft. from the ground runs a wire strung like the trolley wire of an electric railway round the course. Upon this, at intervals of 25ft., are strung clusters of incandescent lamps, with four lights in each cluster. Giant searchlights illuminate the turns. A peculiar arrangement prevents the casting of shadows, which has always hitherto proved the difficulty in horse-racing by artificial light. The grand stand is a blaze of brilliant whiteness, and from it the course is seen mapped out in a light so bright that the colours of the jockeys' jackets are plainly visible. The effect is all the more intense from contrast with the space of darkness that intervenes between the stand and the track. To obviate danger, only five horses are allowed in each race. The only difficulty experienced at the recent meeting was to find sufficient accommodation for the large number of horses entered.

Cardiff.—A meeting of the Lighting Committee of the Cardiff County Council was held on Tuesday, Councillor Vaughan presiding. The town clerk (Mr. Wheatley) and the borough engineer (Mr. W. Harpur) were also present. The report of the sub-committee appointed to make enquiries with a view to securing a suitable site for an electric central station was read. From this it appeared that their efforts to secure land in a suitable locality had failed, the prices asked being prohibitive in some cases, while in others there seemed little prospect of the offers made on behalf of the Corporation being accepted without a serious delay taking place. The members, therefore, were obliged to search for a somewhat less desirable place in other directions, and they suggested the advisability of utilising a piece of ground owned by the Corporation on Canton Common, about an acre in extent, adjoining the Great Western Railway. The report was confirmed, and a resolution passed recommending the Corporation to adopt the suggestion of the sub-committee. It was further resolved that Mr. W. H. Massey, their consulting electrical engineer, be requested to state the terms upon which he would prepare the necessary plans for obtaining specifications and estimates of the proposed works, also the amount of out-of pocket expenses he had incurred during the time he had acted for the committee.

Huddersfield.—An electric transformer sub-station will be erected in connection with the lavatories to be constructed underneath the old Market-place at Huddersfield. At the Huddersfield City Council meeting last week some questions were asked with reference to the price to be charged. Councillor Stocks pointed out that the Council proposed to charge 6d. a unit to begin with, which was equal to 5s. per 1,000ft. of gas. They hoped to reduce it eventually to 5d. Councillor Chrispin said that at some places they were supplying the light at 4d. a unit. Councillor Stocks doubted this; the lowest they could find was at Newcastle, where the price was 4½d. a unit. Councillor Walker wished to know whether, as the sewage works were to be lighted, the neighbouring mills could be lighted from the same source. It may be worth while on our part to point out that now the electric light is being introduced, interest will be great in Huddersfield, and as the woollen mills are scattered over a wide district, many of them out of reach of mains, there should be a fine field for separate installations. We know the ground has been pretty well canvassed for long, but it is only lately that real interest has been taken in the subject. Many of the mills being almost as large as villages, considerable caution has been necessary on the part of the owners. As a rule, the storehouses are in the town itself, and the mills are on the outskirts and even quite in the country.

Chelmsford.—Messrs. Crompton and Co. seem to be doing all they can to make the lighting of their town a perfect success—worthy of a visit from any deputation or engineer. They have secured the distinction of having lighted the first town which is dependent entirely for its public lighting on electricity. The responsibility for initiating, for carrying out and maintaining the light has been borne by them, but the time has now come when this pioneer installation shall be handed over to a separate company. Messrs. Crompton have informed the Lighting Committee that a separate joint-stock company, called the Chelmsford Electric Lighting Company, had been formed, and that they proposed to transfer the lighting of the town to them. The committee recommended that this course should be agreed to, provided that two independent sureties be submitted by Messrs. Crompton for the due performance of the remainder of the contract. They also reported that Messrs. Crompton were intending to fit new arc lamps in the town. Alderman Brown in presenting the report said the matter had been gone into very carefully, Messrs. Crompton themselves offering to become guarantors for the new company. The town clerk read a letter from Messrs. Crompton, in which they stated that the Chelmsford company had been incorporated to meet the requirements of the Board of Trade that the lighting accounts should be separately kept. The report was adopted, on the understanding that Messrs. Crompton and two independent sureties became guarantors for the due performance of the contract. We wish the undertaking success.

Brussels.—The following is an abstract of the remarks of the committee on the tenders for Brussels: Six tenders were received on October 30th last from Siemens and Halske with the Allgemeine Company, Schuckert with Bouckaert of Brussels, International Company of Liege, India Rubber Company, Crompton and Ferranti. The Siemens and Schückert schemes were for central station, continuous current and batteries, and two secondary battery sub-stations (at Quartier Leopold and Avenue Louise) with armoured underground mains. Schuckert presented a second scheme, in which the sub-station at Avenue Louise is for alternating currents obtained from direct-current motors. The International Company differs

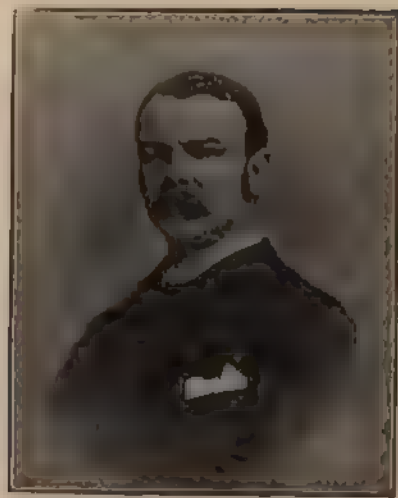
from the two preceding ones by not using batteries in the central station. The engines would be 500 h.p., and the mains paper-covered (Bergmann system). The India Rubber Company propose a single station with 500 h.p. engines, plus a 125-h.p. engine for daily supply, mains on the draw-in underground system, with insulated cables in iron pipes. Cromptons propose both continuous and alternating current high speed engines, and small battery of accumulators with secondary station at the Theatre du Parc, and alternate currents from the central station to Avenue Louise. The Ferranti project proposes alternating currents only. The station at the gas works at Laeken would send current at 2,400 volts to a distributing station, branching off to sub-stations for transforming down to 100 volts. The India Rubber Company's scheme was considered to have most corresponded with the desires of the committee.

Edison-Swan Patents.—The Commissioner of Patents (U.S.), we learn from the American papers, has decided a long-standing controversy between Thomas A. Edison and Joseph Wilson Swan, in favour of the latter. The matter in contention was as to the priority of right to a patent for an electric light carbon for incandescent lamps. The dispute had been pending since 1881. Swan laid claim to having invented the parchmentised paper in March, 1880. He filed his application in April following, and the patent was issued in October following. Edison did not file his application until May, 1881, but he said that he had made and used the invention as early as 1879. Edison asserted his claim under the provision of law which entitles the inventor to his product as soon as he discovers it, and not from the date of his application for a patent. In 1881 Edison filed the following issues of interference: "1. A carbon formed from a straight strip of cardboard paper or parchment paper, and bent to the form of an arch, hoop, or loop, and carbonised by heat while in a bent condition. 2. A carbon for an electric lamp made of the carbonised parchment paper." On these testimony was taken on both sides, and for a time a spirited legal battle was waged. The Westinghouse people took an active hand, for at that time they thought that the parchmentised paper would continue to be of invaluable profit to them. Electrical genius, however, was too fertile to stop at parchmentised paper as the best material for incandescent lamps, and in a few years there were a half-dozen new patents that were considered superior to it. Since that time the case has lagged, not being considered of any material commercial value. Still, we must congratulate Mr. Swan upon his moral victory.

Electrical Work in Mines.—It is nearly 12 months ago since Mr. Albion T. Snell read a paper before the South Wales Institute of Electrical Engineers on "Electrical Work in Mines," which created a great deal of interest. Mr Snell went very fully into the practical outlook of the application of electricity in mines, and the discussion of the paper, which has been put off from meeting to meeting, took place at the annual meeting at Cardiff on Friday last. Mr. Albion T. Snell, in opening the discussion, said when they considered that the easily won coal in the majority of collieries had been got, that a greater depth had to be gone to, and that the forces at disposal were somewhat inadequate, he thought all would be prepared to admit that there were still further means necessary for getting and for hauling coal to compete with foreign countries. Electricity was a force capable of greater efficiency than either compressed air, steam, or ropes, which might here be efficiently applied. There were certain difficulties, such as "sparking" and "firing" when the cables were broken; these difficulties had, however, been overcome. Experiments had been made by encasing the parts where sparking occurred in explosive mixtures, and the explosion had not been communicated outside the casing, and the second risk had also been dealt with. Mr Bailey thought what was wanted to deal with sparking was to get rid of it altogether. Until that were done he was afraid it would have a very deterrent effect in the universal use of electricity in mines, especially fiery ones. In his opinion, the cables should be armour-cased and buried, and then he did not see any danger of breakage. Mr. Sydney Walker wrote, observing that it would be better not to have any armour; plenty of jute would give the same result, at a fraction of the cost and without the danger. Mr. Howell thought the best reply to Mr. Walker was that for 30 years every Atlantic cable had had armour casing. The only way, in his opinion, to avoid the breakage was to make the cable sufficiently strong to stand any strain. Mr Archibald Hood did not think there was a more important subject for the institute to discuss than this transmission of power underground. He had been averse to it at first, but since he had employed it he had determined to increase its application. He had, perhaps, about half-a-dozen electric pumps working underground, and the results in every case were highly satisfactory. Thanks were accorded to Mr. Snell for his valuable and interesting paper.

Geissler Tube Lighting.—A bit of red-hot wire did not look, in the early days, a very promising object with which to reform our system of artificial lighting. Nevertheless, with the efforts of De Changy, Sawyer and Man, Swan, Edison, and the later experimentalists, we have one of the most useful pieces of apparatus of modern times. Of what does it consist? A piece of blown glass, two platinum wires, a carbon wire, and last, but not least, a vacuum. The latter is better defined as a freer path for molecules to vibrate, and although in the present lamp we ignore the molecules, yet in the vacuum tube lamp that may come the "darling little molecules" (as the lady listener at Joseph Cook's lectures called them) will have their full play usefully applied. Given an exhausted tube and a sufficiently high potential current, vibrating sufficiently rapidly—a million or two times per second—the molecules are knocked about together and their surfaces (at least we can imagine so) become incandescent. Surface incandescence is known as phosphorescence, and free molecules of gas are a useful medium for obtaining this glow-worm light. If the Cuban maiden can light her cap with half-a-dozen glow-worms—if the Cuban pressman can pen his note by the light of a handful of these ugly but intensely interesting caterpillars—there is no reason in the world, save the possibility, why we should not attempt to utilise electric phosphorescence seen in the Geissler tubes, multiplied a hundredfold or so, as a useful light. It remains to be proved whether such a light is efficient. We have recently seen some experiments carried out by Messrs. Pyke and Harris, of Westminster, bearing in an interesting manner on this question. The current from the ordinary 110-volt circuit was taken, led through two carbons, giving a feeble arc, taking four or five amperes. This, led into a moderate-sized box, containing a transformer and tinfoil and glass plate condenser, lighted up a special kind of vacuum tube in a very brilliant manner. Mr. Pike has thus lighted, he says, over a thousand of these tubes on a 150,000 volt circuit simultaneously. The tubes are very long, but the tube is coiled in a close spiral, making a compact, brilliant lamp—of moderate candle power, of course. But with a score or two the room is bright. The efficiency of these lamps has not been determined very accurately, but it appears that about one watt

SHELFORD BIDWELL.



PROF. EWING

PROF. D. E. HUGHES.

CLAUDE JOHNSON

A. A. CAMPBELL SWINTON.

per foot of luminous material is the present consumption. High-tension engineers have a most interesting problem before them. Mr. Tesla is convinced the problem can and will be solved, and others in England seem likewise convinced.

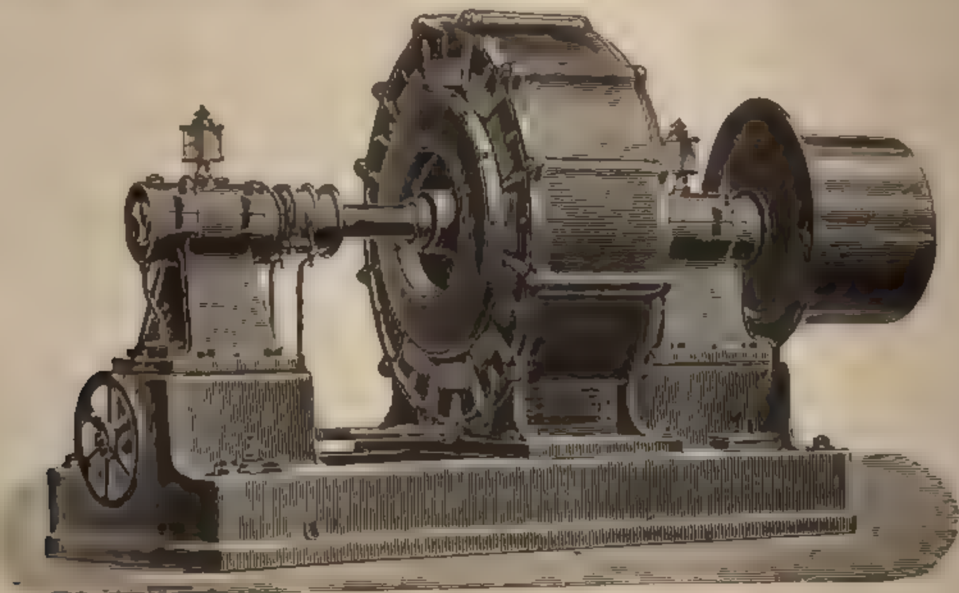
Catalogue.—Amongst the firms who have made themselves a name and a position in electrical circles, the Birmingham firm of Messrs. Fowler, Lancaster, and Co. are very noticeable. Commencing at the time of the first development of electric lighting in this country, they have gone steadily onward increasing their abilities of supply and the variety of their manufactures, until they may be said to occupy the position of principal electrical manufacture and supply company in the Midlands. Their first great hit was the china bases for electrical fittings, of which they were pioneers. To them is due the now almost universal screwed china covers; for it was not until after long experiments and insistance that the china makers would undertake to produce this class of goods with exactitude. Other branches have been added to the works—large and small orders are undertaken, from a complete installation downwards. The engineering of exhibitions, a most difficult thing to undertake well and quickly, has been carried out by them. The firm not long ago was converted into a limited company, and still grows. We have now received the catalogue of the company's manufactures and supplies—a really imposing book, plentifully and well illustrated, comprising electrical plant and fittings of every desirable kind from boiler down to pendants. Lancashire and Cornish boilers are shown in perspective section—a good idea for customers. Locomotive, water-tube, and other boilers are given, and then semi-portable engines, passing to horizontal and compound engines, with Richardson's electric governor and triple-expansion gear. High-speed direct-coupled engines and dynamos find a large place, as is right according to the best present practice, and gas engines, oil engines, and turbine, all find their place. The firm do not recommend any special dynamo, but along with their own do a good turn to every other first-class maker by recommending their products—high - and low, direct and alternating. Special attention, however, is given to electro-depositing machines, for which there is a great demand in Birmingham. The best show of their own manufactured goods is undoubtedly in the fittings, where some magnificent switchboards are shown, as designed for the Post Office, Birmingham, and elsewhere. Main switchboards for stations, house and charging switchboards are shown; switchboards for mixed arc and incandescent circuits, for electro-deposition and so forth, descending to branch and fuse boards. The various kinds of the switches and fuses shown are too numerous to mention in detail, but here the catalogue excels. We have double-pole, double-break, main, and branch switches of all kinds—strong contacts, and good electrical engineering design. Their patent "lever-bar" cut-out is one of the best and simplest. A bar with two contacts and a hook pivot carries the fuse; it is hooked on and pressed into place in an instant, and a spare fuse bar can always be kept hung up handy. Of decorated china switches there are a great number illustrated, and of ceiling roses the same. But the most noticeable feature, perhaps, is some 60 large pages filled with designs of ornamental fittings for electric light. A very large number of very handsome designs are here illustrated in a clear and effective manner. An immense amount of pains has evidently been taken with this catalogue, which ought to be inspected to be appreciated.

Islington.—The Islington Vestry, encouraged by the success of the St. Pancras central station, contemplate the establishment of their own central station for public and private supply on the same lines as at St. Pancras, and to this end they will apply to the Board of Trade for the necessary provisional order. A special committee appointed by the Vestry state in their report that in St. Pancras there is no likelihood of any charge being made upon the rates because of the public electric works, as the receipts will, upon the present basis of charge—6d. per unit—more than meet all expenses, including interest upon loans. Prof. Henry Robinson, electrical engineer to the St. Pancras Vestry, was consulted by the special committee, and in an elaborate report points out that Upper-street, Holloway-road, Seven Sisters-road, and other great thoroughfares in Islington "afford a most favourable field for the supply of electric light," and that "all experience proves that the requirements of such thoroughfares are so certain to result in remunerative business that no element of doubt or speculation is involved." Prof. Robinson shows that Islington can be supplied from two stations — one for the area to the north-west of the Great Northern Railway, and the other for the area to the south-east. These are estimated to cost, including sites and fittings, with engines, dynamos, and other electrical apparatus, but excluding mains, £50,000. About 5½ miles of mains could be laid for £35,000. Hence £85,000 altogether would be needed for two stations capable of supplying at the outset 12,000 lights of 16 c.p. (or 24,000 lights of 8 c.p.) in use at the same time, or equivalent current for motive and other purposes. One installation only would cost about £45,000. Prof. Robinson estimates that each of the stations he proposes would earn at least £9,000 per annum if the charge were 6d. per supply unit, but he points out that by charging a reduced rate to consumers who require the current for exceptionally long hours, the earning power of a station can be increased; and this policy induces people to use electricity for motive power, or for lighting basements during the day, thus employing the machinery when it would otherwise be idle. Hence St. Pancras Vestry has decided to charge 3d. per supply unit for current supplied during the day, while the charge for general purposes is 6d. If his plans be adopted, Prof. Robinson says: "No contribution from the rates would be involved, even during the initiation of the business, as the demand will grow with sufficient rapidity during the first year to enable the stations to not only pay their own way, but at the end of the year to be earning enough to make ample provision for the depreciation fund." Further, he shows that an equal illuminating power can be obtained from electricity as from gas at about the same cost as the latter is now charged in Islington. Finally, he remarks: "The current for public lighting can be produced at a very much lower rate than for private lighting, because the street lamps are required for about 3,800 hours per annum, and thus reduces the proportion which the fixed charges (on capital account) bear to the total cost of working. The effect of the reduction is to bring down the cost for public lighting to 2d. per unit, while the corresponding cost for private lighting is 4·8d. per unit. If a company supplied the current instead of the Vestry, the cost of street lighting would probably be doubled. Incandescent lighting in the streets cost about the same as gas lighting. Arc lamps are more suitable for street lighting than incandescent lamps, because they yield six or seven times as much light for the same expenditure of energy. The cost of lighting a street with arc lamps is greater than the cost of lighting it with gas, but if the comparison is made on the basis of light for light, the result comes out distinctly in favour of electricity."

ALTERNATE-CURRENT DYNAMOS.

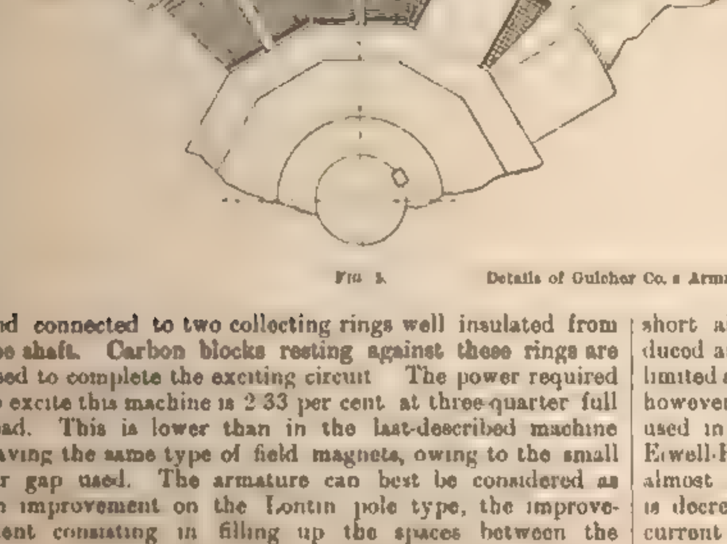
BY R. W. WEEKES, WHIT. SCH.

The Gulcher Company.—This company exhibited one of the Fricker alternators, used in this case for low-tension work. It is difficult to obtain an idea of the construction of the machine from the external view, but the sections this firm have kindly given me will make it clear. The field magnet details are somewhat similar in shape to those of the Elwell-Parker alternator, but there the similarity



The Gulcher Co.'s 30-Kilowatt Alternator.

ends. The magnets consists of a heavy star-shaped casting, having 12 radial arms in the machine exhibited. This casting is mounted on the spindle. The exciting coils are wound on bobbins made of sheet iron, with brass flanges, and the depth of winding increases with the radius, so as to get as much wire on as possible. The bobbins are slipped on and held in position by two iron bolts which screw into the hub, and are riveted into the upper flanges of the bobbin. These bolts take all the centrifugal strain, which tends to throw the bobbins off. The coils are all connected in series



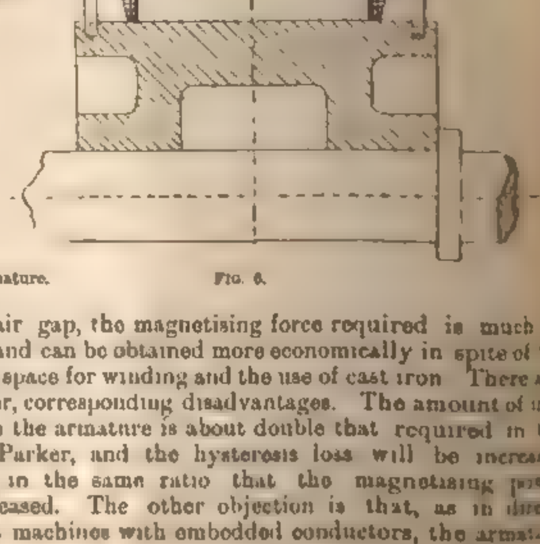


FIG. 5. Details of Gulcher Co.'s Armature. FIG. 6.

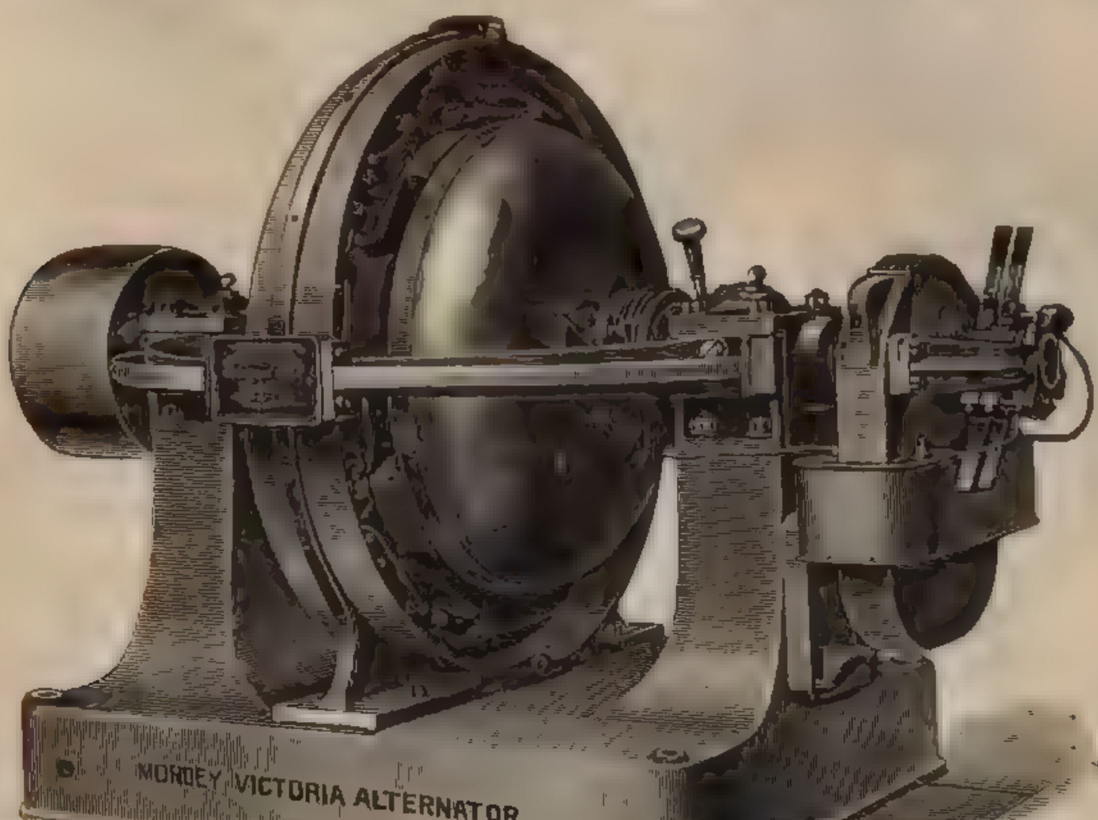
and connected to two collecting rings well insulated from the shaft. Carbon blocks resting against these rings are used to complete the exciting circuit. The power required to excite this machine is 2·33 per cent. at three-quarter full load. This is lower than in the last-described machine having the same type of field magnets, owing to the small air gap used. The armature can best be considered as an improvement on the Lontin pole type, the improvement consisting in filling up the spaces between the poles with iron, to prevent the variations of magnetic flux

In this machine, Figs. 5 and 6, the armature is built up of charcoal-iron plates ·016in. thick, placed radially, and so shaped that when completed they form a complete ring with 24 slots in it, into which the armature coils can be placed. These plates are clamped together in a frame by the bolts passing through the cast-iron end rings. The armature conductor used is copper strip ·162in. by ·08in., and 25½ turns of this are wound on edge on a former. When taken off, the coils are well baked and shellaced before being packed into the grooves in the iron. The insulation used between the core and the conductor is shellaced asbestos and fibre or a thin liner of teak. Thus, when completed, the coils are completely embedded in iron. The advantages of the construction in this type of dynamo are: First, the iron path in the armature offers nearly constant resistance wherever the poles may be, and hence there is little surging of magnetic lines. This does away with the necessity of laminated field magnets, such as are used in the ordinary Lontin type machine. Second, owing to the short air gap, the magnetising force required is much reduced and can be obtained more economically in spite of the limited space for winding and the use of cast iron. There are, however, corresponding disadvantages. The amount of iron used in the armature is about double that required in the Elwell-Parker, and the hysteresis loss will be increased almost in the same ratio that the magnetising power is decreased. The other objection is that, as in direct current machines with embedded conductors, the armature reaction is much increased owing to the small air gap.

Thus, when working, the exciting current will have to be varied considerably to prevent alteration in the potential differences at the terminals when the load is varied. Also with high voltages the insulation of the embedded coils would be a rather difficult matter. The armature coils were all connected in parallel when at the exhibition, and then gave 100 volts and 300 amperes. The advantage of using 25½ turns in each coil is that the half turn makes all the inside ends of the coil on one side of the armature, and all the outside ends at the other. Thus, when connecting in parallel, a simple ring of conductor is required to connect all the ends on one side together. The coils can, of course, be removed individually if one should become damaged, and to facilitate this the whole armature is placed on slides, and can in a short space of time be moved along parallel to the axis till clear of the armature field. A multiple threaded screw is used to obtain the necessary force, and at the same time a fairly rapid motion. The slots in the armature iron into which the coils are placed cause a slight variation of induction at the surface of the magnets. To prevent eddy currents in the iron, grooves of about $\frac{1}{16}$in. broad are turned in it ¼in. deep. The general construction of the bearings, etc., is well arranged, and the machine makes very little noise when working.

The following are the details of the 30-unit alternator made by this firm: Output, 100 volts 300 amperes at 700 revolutions; then it gives 70 complete periods per second; weight complete, 30cwt.; floor space, 4ft. 10in. by 3ft., height 4ft.; armature conductor, 08in. by ·162in., wound in 12 coils of 25½ turns each; weight of conductor, 39lb. 12oz.; magnets of cast iron, of 10in. by 5½in. section.

The Mordey Alternator.—This machine, although classed with those having fixed armatures and moving fields, differs in both principle and detail from any described above. In this alternator the direction of the lines of force through the armature coils is never reversed, as in all previously described machines, but the E.M.F. is produced by a variation of the magnetic field through the coil from the maximum to practically zero. This is done by having twice as many coils as there are poles. Then when one coil is directly opposite a pole, and hence has the maximum field throughout it, the adjacent coils are midway between two poles, and have practically no magnetic flux passing through them. The field magnet design for obtaining a number of consecutive poles of the same polarity is simple and easy to manufacture. The magnetic circuit consists practically of a short bar of cast iron excited by one large coil, and with inverted claw pole-pieces fastened on either end to form the returning path of the magnetic lines. In the alternator, the centre core, of cast iron, is keyed to the shaft, and the star-shaped end castings having the number of poles required are bolted against each face of this. The exciting coil is wound on a strong bobbin, which slips on the core. In the centre of the coil there is a space left in the winding to clear the armature coils. The advantage of thus causing the armature to project into the coil is that the magnetic circuit can be then shortened radially. The exciting current required is taken by two brass rings connected to the exciting coils, but the method of connecting to the revolving ring is better than the ordinary brush arrangement. It is done by means of a flexible band of copper gauze so folded as to give a rectangular section. The one end of the strip is secured to the terminal and the other has a weight attached. Thus, when hanging over the brass collecting ring, the weight gives the tension required to ensure perfect contact. The magnetic leakage with this type of field will be exceeding small, as the adjacent poles on each side of the armature have the same polarity. The armature coils are wound on cores of porcelain, which gives stiffness and good insulation without the disadvantages of the metallic core—*i.e.*, hysteresis or eddy currents. The conductor is a copper strip, which is wound bare with a strip of insulating material between each layer. The inside and outside ends respectively are connected by flexible conductors through the German-silver clamps, which hold the outer end of the coil. The bolts holding these plates of German silver on to the coil are all provided with spring washers, so that the grip on the porcelain is to a certain extent flexible. One side of the clamp is faced up in the lathe, so that when it is placed against the frame of the armature it ensures the coil being in a plane perpendicular to the axis. In the larger alternators



Mordey Victoria Alternator

the inside end of each armature coil has also a small brass clamp over the conductors to prevent any displacement of the individual strips taking place. The frame of the armature consists of a large ring usually cast in half and bolted together, Fig. 7. One radial face is machined in the lathe, and to this the coils are bolted. The bolt holes are elongated radially, so that the coils can be packed more tightly together after the working strain has compressed the various parts, and hence loosened them. The armature coils are connected half in series and the two halves in parallel to prevent a high potential difference between adjacent coils in all alternators having an output of about 50 kilowatts.

The mechanical details are well designed and carried out, the oil arrangements being automatic. Two small oil pumps are driven by belts off the main shaft, and ensure a good circulation of oil all the time the machine is at work.

Fig. 7.

The following are some particulars of the Mordey alternator recently shown at the Crystal Palace: The 100-kilowatt alternator gives 2,000 volts and 50 amperes at 430 revolutions. The weight complete is 9 tons 1cwt., and the floor space occupied is 8ft. 3¼in. by 6ft. 4¾in. The armature ring is 5ft. 10in. diameter and has 28 bobbins. There are 14 poles to each magnet casting, thus giving 100 complete periods per second. The magnets are 4ft. 8in. mean diameter, and the armature ring is 5ft. 10in.

The details of the weight are:

	tons	cwt.	qr.	lb.
Shaft	0	8	3	18
Bed-plate	2	10	2	0
Armature	0	10	1	12
Each magnet casting	1	16	2	0

The 50-kilowatt machine gives 2,000 volts and 25 amperes at a speed of 100; weight complete, 4 tons, floor space, 6ft. 7½in. by 5ft. 6¼in.; the armature ring has 20 bobbins, and is 4ft. 6in. diameter. The magnets are 3ft. 4½in. diameter, and each pole has 10 pole pieces.

Details of weight:

	tons	cwt.	qr.	lb.
Each pole	0	15	1	20
Magnet spool	0	13	1	22
Armature ring complete	0	6	0	20
Shaft	0	2	3	15
Bed plate and bearings	1	5	3	0

ELECTRIC RAILWAY MOTOR TESTS.*

BY PROF. GEO. D. SHEPARDSON AND EDWARD P. BURCH.

(Concluded from page 121.)

A large number of running tests were made on cars in regular service. Fig. 8 shows a run on the interurban line between Minneapolis and St. Paul. The distance is about 10 miles, the schedule time 55 minutes, cars equipped with two 25-h.p. single reduction motors. Special trains sometimes make this trip in 30 minutes or less. Fig. 9 shows three runs on the University line of Minneapolis on successive days, with the same car and same driver. The lower curve was taken when the rails were dry and dusty, middle curve with wet rails, and upper curve when the ground was covered with snow, 8in. deep on the level. The snow-plough had been over a part of the track about an hour before. The curves show variation of time, number of passengers being noted.

	Feb. 5.	Feb. 6.	Feb. 7.
Condition of track	Dry	Wet	Snowy
Number of stops	38	50	[illegible]
Average voltage	445	450	440
Average amperes	15·15	14·9	[illegible]
Average amperes while working	23·4	20·9	[illegible]

It will be noted that the current was less with wet rails although there were more passengers. The load at the station is about the same for a rainy day as for a dry, the difference being probably made up by the increased water on the lines and by the larger number of passengers on some cars.

Fig. 9 shows variation of current on a single car. Fig. 10 shows variation of current on a feeder to line with [illegible] cars, the average current being about 60 amperes. Fig. [illegible] is plotted from readings taken at intervals of two seconds. The ammeter stops some little time at the high and low points, showing that these are actual values of the current and not due to the inertia of the ammeter.

Fig. 11 gives the results of readings, one second apart, taken on the main ammeters in Minneapolis and St. Paul, and on one feeder in Minneapolis. There were about [illegible] cars on the Minneapolis line, 100 on St. Paul lines, and [illegible] on the one feeder.

Fig. 12 gives the daily load of the Minneapolis power house, the curves being plotted from readings of the ammeters taken at 10 minutes' intervals throughout the day. In this case the power units are unusually large, there being two triple-expansion condensing [illegible] engines, the constant loss from friction in engines, shafting and dynamos averaging 218 h.p. Indicator cards were taken simultaneously by means of electromagnetic attachments on each of the 12 indicators, the same current also giving signals to the observers at the ammeters.

A series of 13 tests were made for ascertaining the effect of wetting or greasing the rails on a curve. Two cars were coupled by a spring dynamometer and the pull noted while rounding the curve at ordinary speed, which was kept nearly uniform by means of a brake on the motor car. The average pull on the dynamometer is as follows:

	Dry.	Wet.	Greased.
Outer track	500-800lb.	400lb.	300[illegible]
Inner track	650lb.	400lb.	400[illegible]

The inner rail was wet or greased in each case, but on the inner track the greasing was not so thorough on account of the lateness of the hour. It is noticed that wetting the rail reduces the power required about one-third, and greasing reduces it one-half. Readings of the ammeters on the car correspond in general with the dynamometer readings.

The "bucking" of street-car motors is a subject of considerable interest to street railroad men, although it seems never to have been discussed in public. From the [illegible] of the books and papers, and from the ideas current among railroad employes, the conclusion is reached that little is known about its conditions, causes, or remedy. It is therefore thought wise to present the results of observations and tests, with a theory for the cause and remedy. It sometimes happens that an electric car suddenly stops and [illegible]

* Paper read before the American Institution of Electrical Engineers.

These buck worse when run on the "loop"—*i.e.*, with part of the field coils cut out, some of them bucking regularly

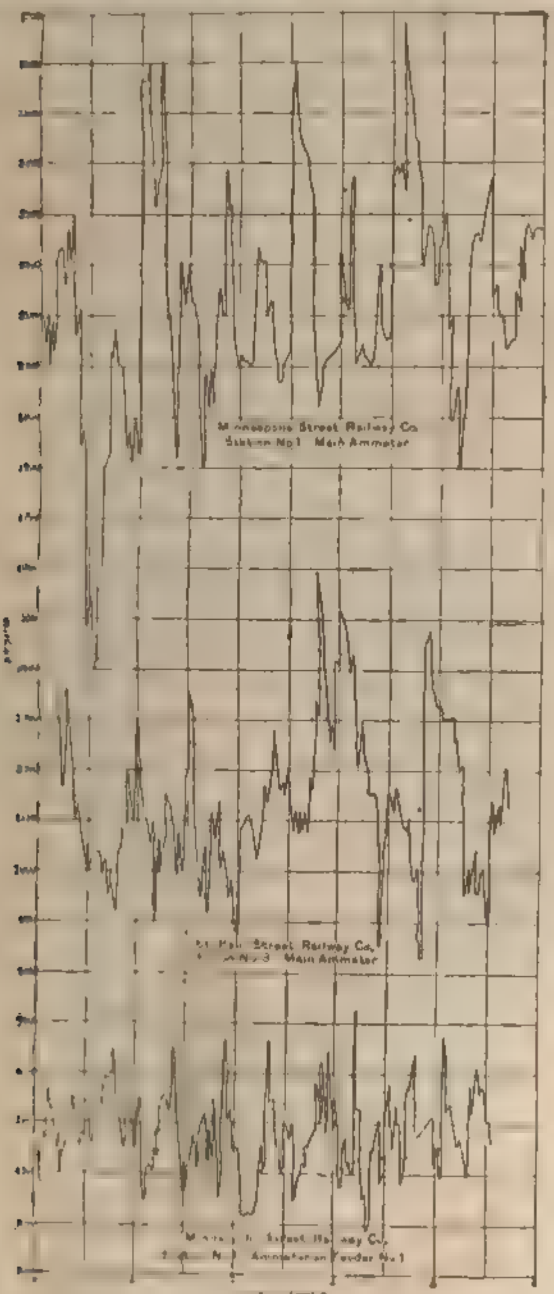


Fig. 11.

every time the loop is cut out. This is one reason why the use of the loop has been abandoned on this road except in a few cases. The machines with commutated fields would buck when the field coils became old, although they showed no signs of being grounded. Bucking became much less frequent when the commutated fields were replaced by a single pair of series coils.

It was noticed that bucking was very commonly preceded by flashing at the brushes, although flashing was not always followed by bucking.

The explanations offered are various. One is that the iron in the fields varies in magnetic quality, so that one motor works harder, and by some means acts upon the other as a dynamo. Another is that one motor becomes reversed while the other does not. Another is that bucking is caused by poor brushes or brushholders.

One explanation offered was that a partial break in the circuit, such as may be caused by shaking a loose connection, induces a high E.M.F. that causes a flash to span the commutator.

In searching for a reasonable explanation for all these cases in which no second ground connection existed, it was noticed in each case that bucking was more liable to occur when the field was comparatively weak; also where the armature reaction was greater. In each case the neutral line is shifted, and the coils under the brushes are in an active field. The large current in short-circuited coils further distorts the field, and the sparking at the brushes becomes excessive, causing a vigorous flashing. As soon as the counter E.M.F. in the sections leaving the brushes rises above 20 volts, the arc is carried around from one brush to the other, thus grounding the positive brush and short-circuiting the armature, which then acts as a dynamo and causes the motor to buck. Such bucking is usually less vigorous than when caused by a dead ground, on account of the resistance of the arc. This explanation covers all the cases noted.

Such being the causes of bucking, the remedies are plain. Armature reaction must be reduced. This militates against the conclusion drawn by Mr Parshall in his recent Institute paper, that the strength of field is of little importance, and that the windings of the armature should be a maximum. The liability to bucking would be reduced even when there is a large armature reaction, if the armature is divided into a large number of sections.

An obvious remedy for bucking caused by direct grounding would be to connect the fields between armature and ground instead of between armature and trolley. With such an arrangement, a ground on the fields would simply cut out a part of the coils, and cause that machine to work harder. A ground at brush between armature and field would cause a sudden forward impulse on account of the field requiring some time to lose its magnetism, and would blow the fuse. A ground on armature would likewise cause a sudden forward impulse and blow the fuse. With such an arrangement there would be no true bucking except in case of the flashing as noted. An incidental advantage

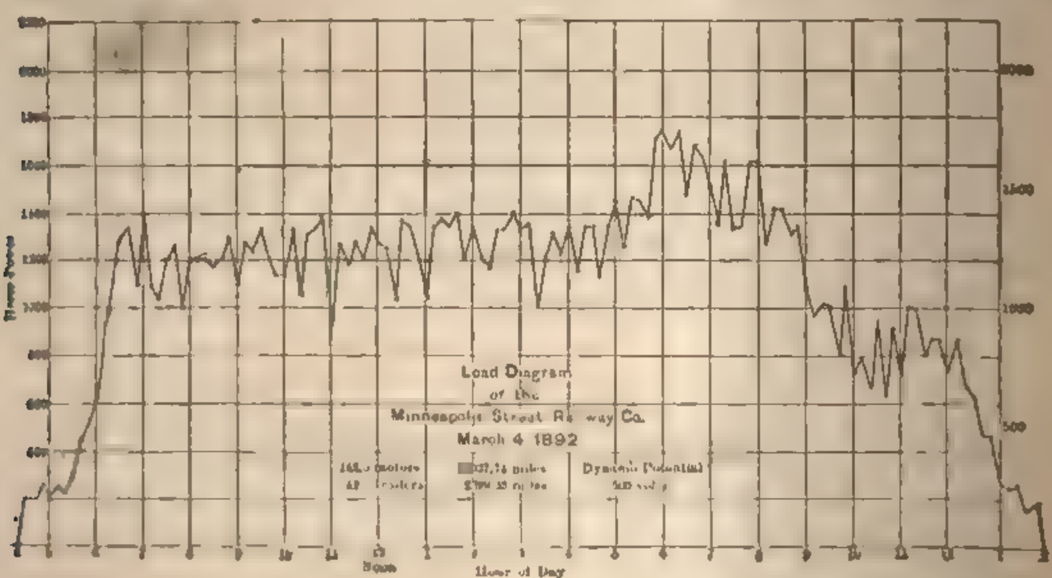


Fig. 12.

of this arrangement is that the difference of potential between the field and the frame of the machine is reduced to a few volts caused by the drop through the field; hence there is less danger of grounding the field. The increased difference of potential between armature and core is only a few volts, and would not affect the insulation very much.

TRANSFORMERS.

One objection to the Ferranti type of transformer seems to be the trouble of a repair when a burn-out occurs. In this class of transformer the iron is placed in bands, which are bent over, and these in case of repair have to be bent back by main force, the coils repaired, and the whole replaced in original position, the process often taking a day or more. If the coils could be slipped out easily and fresh coils put on, a transformer need take only 10 minutes or so to repair. We have lately seen an improved arrangement of this nature, which seems to have much to recommend it. The thin iron plates are made in square horse-shoe shape, with two legs; these plates overlapping alternately, form a square core with hollow centre, in which the coils can just be placed. The plates are arranged radially round a centre, giving space for air ventilation or circulation of oil. To repair, the binding wire is cut, and the top halves of the plates are lifted off, leaving the coil free of access. The plates can be slipped back and refastened, the whole operation being simple and easy for an ordinary workmen, and taking very little time. As the use of transformers extend, these practical points will become quite as important as comparative efficiency.

ABERDEEN.

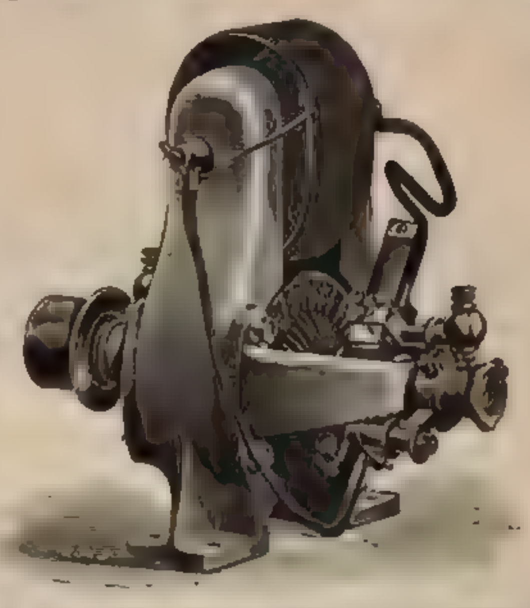
Acting on the report by Prof. Kennedy, the Gas Committee of the Aberdeen Town Council on Tuesday resolved, on the casting vote of Bailie M'Kenzie, the convener, to adopt an instalment of electric lighting for public and other buildings in the city. The amendment to the resolution demanded delay until it was ascertained how many persons were likely to use the light. As Prof. Kennedy understood that the Council do not at present contemplate doing anything in the direction of public lighting of the streets he confined himself in his report to the best method of supplying the electric light to shops, offices, and public and private buildings. It is in the area, described as the eastern district, in which he considers operations should be commenced. Dealing with the probable demand for light, he says it might be taken that the electric light in a private house would cost 25 per cent. more than for gas, and in a shop or club 75 per cent. more. He started on the assumption that the income per foot of street frontage would be about one-fifth of that derived at present from the sale of gas along the same frontage, and on that estimate about 10,000 lamps of 8 c.p. would be installed, of which about 7,000 would be in the eastern and 3,000 in the western district—a number that ought to be installed within two or three years' time. The site recommended for the central station is one adjoining the gas works at Cotton-street. As to the system to be adopted, Prof. Kennedy considers that the conditions existing in Aberdeen point distinctly to the use of batteries which can be charged during a few hours out of the 24, and can then supply a current during the long light hours without the necessity of running boilers or engines for the purpose.

Four different systems are described in detail which are reasonably possible in the case of Aberdeen. The first of these is one in which a high-pressure alternating current may be used, but while in capital cost this system would be least expensive for Aberdeen, it would render necessary the continual running of machinery in the station day and night. The second system mentioned is one of using a limited number of large transformers in sub-stations, and the third, the system in use in London and Oxford, by which a continuous current is transmitted from a central station at high pressure through feeders to a number of sub-stations, in each of which it is transformed down by a "dynamotor" to a low tension and then distributed to the consumers' premises through ordinary low-tension network. The fourth is the direct system with batteries. There would be no difficulty in supplying the eastern district on an ordinary direct-current system, used with battery at the Cotton-street station, so that there would be no [illegible]t, machinery, or apparatus of any kind outside the central station itself. According to this plan, there would be the advantage of having only a single system in the station, of having a reduced amount of copper in the long-distance feeders, and of being able to shut down the station and run off batteries at low loads and during daylight hours. The use of the continuous current would also allow them to supply currents for power—*i.e.*, for driving of motors of any kind if it should be required. The mains, it is proposed, should be laid underground. To run the works economically, he recommends to be put down at the station five dynamos, having a capacity of about 260 e.h.p. for the eastern district, each dynamo to be driven by its own engine. Under the system which he advised them to adopt, the price, including batteries, would be £19,900 and £30,600—the former for the eastern district alone, and the larger sum for the two districts together. As to income, it is estimated at 9s. per annum per lamp installed, or £4,500 by the time they had the equivalent of 10,000 lamps on current. Prof. Kennedy estimates that the additional cost in fuel, stores, and wages of working a high-tension alternating current system, as compared with that which he recommended, would not be less than £500 per annum. As the saving in first cost would only be about £3,300, the balance of economy remained in favour of the system he recommended.

TRADE NOTES AND NOVELTIES.

Small Electric Motors.

The "S.M." electric motor has been designed to meet a considerable want in connection with electric supply companies for a really useful small motor. Hitherto small motors have been little better than toys, and not suitable for commercial use. The "S.M." electric motors, however, placed upon the market by Messrs. Ernest Scott and Mountain, Limited, of Newcastle-on-Tyne, are made upon lines dictated by long practice in the designing of dynamos and motors of large capacity, and whilst of small size, embody all the special features in engineering and electrical design necessary to ensure satisfactory working.



These motors will be found of great value for driving small workshops, lathes, machinery, fans, sewing machines, and for many other purposes where small powers are required and electric current is available. In private houses and mansions, where electric light is installed, they will be found extremely useful for driving fans for ventilation, pumps for the house supply of water, churns or butter-making machinery, saws for cutting firewood, boot-blacking, and other household purposes for which electricity might be used.

The "S.M." electric motor is made in four standard sizes, and in ordering it is only necessary to state the E.M.F. of the current and purpose for which it is required. The motors are made in four sizes: ¼ h.p., ½ h.p., ¾ h.p., and 1 h.p. effective. They are made to run at speeds of about 1,500 or 2,000 revolutions, but can be wound to lower speeds if required, to suit requirements.

Electric Lock.—An ingenious application of well known principles to an electric lock allows any door or gate to which it is attached to be either unlocked and left in this condition, or permanently locked from any desired point.

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CONTENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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NOTICE.

With this issue of the Paper is given a Supplement containing Portraits, taken from photographs, of **Prof. D. E. Hughes, Mr. Shelford Bidwell, Prof. J. A. Ewing, Mr. W. C. Johnson,** and **Mr. A. A. Campbell Swinton.**

Every reader should see that he gets this Supplement, and non-delivery with the Paper should be reported at the Publishing Office.

THE BRITISH ASSOCIATION.

On Wednesday last the fifty-ninth meeting of the British Association met at Edinburgh, under the presidency of Sir Archibald Geikie. This is the fourth time that the association has met in the capital of Scotland—its fourth meeting in 1834, its twentieth in 1850, its forty-first in 1871, were the previous meetings. Since the first Edinburgh meeting the whole of the applications of electricity now utilised by the world have germinated and fructified. In 1834 telegraphy was in the unknown, telephony was not foreshadowed. True, the dynamo was born, but no use had been found for it, nor was the apparatus looked upon as much more than a laboratory toy. Electro-deposition was of later date, as, of course, were electric lighting and transmission of power. According to our views the world has moved very fast in the half century that has since passed, but we are probably as much in the dark now as to what will be common property to the world of 1950, as were the good people who met in Edinburgh in 1834 to what is common property now. The carping critic might well ask what part has the British Association played in this march of electrical progress. The answer ought to be instantaneous, that the existing system of measurement is due to the work of the association. We may not be altogether enamoured of the system as applied to engineering work, but undoubtedly the consolidating and experimental work under the auspices of the British Association, so far as units and measurement are concerned, has proved of incalculable value. It may be doubted if the modern methods of sectional discussion are likely to lead to anything valuable. Long-winded speeches are made with no real objective. A does not agree with B, and C does not agree with either. Still, the bringing out of divergent opinions may lead to definite agreement at no very distant day. There will be some one or other direction toward which men's minds will tend, and in this direction something satisfactory may ultimately be obtained. As year after year passes we are becoming more and more dissatisfied with the work of the sections. The papers obtained are many of them not fit for discussion. Many are preliminary observations with promises of future performances, which further investigations relegate to the Greek kalends. It is something approaching to a disgrace for a so-called scientific assembly to admit many of these papers, but no doubt there is another side to the question. If we are bold and blunt enough, we shall admit as at present conducted the British Association is but a huge scientific picnic, the papers and sectional meetings being but a framework to hang a number of other meetings upon, at which scientific conversation does more to make friends acquainted with the work and progress of the past year than anything else at the meeting. Were it not for these social gatherings, the presidential addresses, and the reports of committees, the British Association would soon die of inanition. Of course there are good papers among the rubbish—sufficient, perhaps, as things go, to leaven the mass and make the sectional proceedings acceptable. It is unfortu-

nate that the mass of younger contributors are permitted to add so much immature and speculative matter to the proceedings. Another important want is a kind of unbiassed judge who will undertake the somewhat onerous task of sifting the wheat out of the set discussions, and presenting it as simply and baldly as possible to the eyes and ears of those to whom the scientific verbose jargon is a dead language. Who now knows the conclusions, if any, upon which the disputants are agreed? The summing up of a judge is sadly needed. With regard to the discussions on papers read in the sections, the secretaries are apt to provide too many papers, and thus sometimes to burke an interesting discussion, though usually the discussion is merely formal. This defect would easily be met by weeding out the objectionable papers. It may, however, happen that all these remarks are out of date; that fewer and better papers will be before the sections at Edinburgh; that greater care will be taken to make clear the points under discussion; and that at the end of the meeting we shall have to acknowledge that the British Association, although approaching its sixtieth anniversary, is by no means played out as a leading institution in the realms of science. Let us hope the meeting at the modern Athens will be without the bad features of some of its predecesors and superabundant of all their good features.

OUR PORTRAITS.

Hughes, Prof. David Edward, F.R.S., was born in London in 1831; his parents, however, emigrated soon after to the United States. He was in 1850 (on account of his musical talents) appointed professor of music at the College of Bardstown, in Kentucky. His equal talents for physical sciences later on procured him the appointment to the Chair of Natural Philosphy at the same college. His first great invention was that of the printing telegraph which bears his name. In 1855 he took out his first patent for this instrument, which he sold the next year to the American Telegraph Company, of New York, who soon after amalgamated with several other telegraph companies owning the Morse patent, forming the present Western Union Telegraph Company. In 1857 Prof. Hughes visited Europe in order to try and get his instrument tried upon the lines of the Electric Company, but in this he did not succeed until 1863, when the patent was purchased and the instrument used by the United Kingdom Electric Telegraph Company, of London. In 1859 he invented and patented an oil cable for submarine and subterranean electric wires, in which the principle of the self-restorative powers of rosin oil, together with its high insulation, was used for this purpose. From 1857 to 1860 Prof Hughes tried in vain to get either his instrument or his fluid cable adopted in practice. He then went to France, where the printing telegraph was at once placed in actual service between Paris and Lyons, and after one year's continued working the system was finally adopted for all the important lines of France. Prof. Hughes was then decorated with the Order of the Legion d'Honneur, of which order he was made Chevalier, and also nominated a member of the Commission de Perfectionnements At the end of 1862 the Italian Government invited Prof. Hughes to visit Italy and instruct their officers in the use of his instrument, where, after a practical trial of six months, his instrument was finally adopted for the station lines. In 1863 the instrument was adopted by the United Kingdom Company, and in 1870 by the Submarine Telegraph Company, who were all merged into the present Government postal department. In England, the instrument is now used between London and all the large foreign capitals for their continental traffic. It is also used by the *Times*, *Daily Telegraph*, *Daily News*, etc, for their foreign telegrams. In 1864 Prof. Hughes visited Russia, where the system was also adopted for their line. Between 1864 and 1876 this instrument was successively adopted by Germany, Austria, Turkey, Holland, Switzerland, and Spain, and in every country up to this date the use of the instrument has been of a progressive and increasing nature. In 1878 Prof. Hughes announced through a paper to the Royal Society his discovery of the microphone, which is now universally employed as the transmitter to the telephone. In 1879 he presented to the Royal Society his invention of the "induction balance," now well known by the scientific world. In 1880 he was elected a Fellow of the Royal Society, and in different years, and by different Governments, he has received the high decorations of Commander Legion d'Honneur (France), Charles III. (Spain), Iron Crown (Austria), Medjedieh (Turkey), and Knight of St. Anne (Russia), St. Maurice and St. Lazarus (Italy), St. Michael's (Bavaria), and he received the special gold "Grand Prix" (one of ten only) Paris Exhibition, 1867, as well as the Grand Diplome d'Honneur, Paris, Diplome d'Honneur, Paris Electrical Exhibition, 1881, besides numerous other medals, such as Royal gold medal of the Royal Society, etc. In 1886 he was elected president of the Institution of Electrical Engineers. He is now a member of numerous committees, and also one of the managers and vice-president of the Royal Institution of Great Britain. Thus far we follow the biographical notice from "Men and Women of the Times," but it is well known that we are inclined to look upon Prof. Hughes as one of the modern heroes of science, whose example may be followed by those of the younger generation who aspire to "leave footprints on the sands of time."

Ewing, James Alfred, was born at Dundee in 1855, and after schooling there went on to Edinburgh University, where he developed his taste for engineering under Fleeming Jenkin, and for physics under Prof. Tait. Entering the service of Thomson and Jenkin, he received a practical training in telegraph engineering, at a time when it was still true that the testing room of the cable factory was the best laboratory in which an electrician could be trained. He took part in the laying of the Western and Brazilian and other cables, and assisted in the development of several of the chiefs' electrical inventions. In 1878 he was appointed Professor of Engineering in the University of Tokyo, Japan—a post which he held for five years, resigning it in 1883 to become professor of the same subject in the college then newly founded in his native town. In Japan, and again in Dundee, he devoted much time to electrical work, beginning while at Tokyo the experiments in magnetism with which his name is specially connected. A little more than a year ago he received the appointment of Professor of Mechanism and Applied Mechanics in the University of Cambridge, where he is now throwing himself into the work of establishing a laboratory and building up an engineering school. Prof Ewing is the author of many papers on engineering subjects, but to electrical engineers his best known writings are the papers in the *Philosophical Transactions* and elsewhere, which contain the results of his magnetic investigations. His theory of molecular magnetism became generally known at the British Association meeting of 1890, when he showed a model exhibiting the process of magnetisation. His treatise on "Magnetic Induction in Iron and other Metals," published in the beginning of the present year, gives an account of his own researches as well as the work of others, and brings the subject up to date. At the meeting of the British Association now being held in Edinburgh, Prof. Ewing will read a paper which we make bold to say will prove the most practically important read at this meeting. Prof. Ewing is a member of the chief engineering institutions, as well as a Fellow of the Royal Society; he is a B.Sc. of Edinburgh, and an M.A. of Cambridge.

Bidwell, Shelford, M.A., LL.B., F.R.S., M.I.E.E. Born March 6, 1848. Educated privately and at Caius College, Cambridge. Graduated B.A. (mathematical tripos) in 1870, LL.B. (law tripos) in 1871, and M.A. in 1873;

called to the Bar (Lincoln's Inn) in 1874. He has devoted much time to experimental scientific work, especially in connection with electricity and magnetism. Accounts of his researches are contained in numerous papers published in the *Philosophical Transactions* and the *Proceedings* of the Royal Society, the *Proceedings* of the Physical Society, the *Journal* of the Institution of Electrical Engineers, the *Philosophical Magazine*, *Nature*, and other scientific periodicals. Among the most important of his investigations are those relating to the magnetisation of iron in strong fields, to the changes of length which bars of iron, nickel, and cobalt undergo when magnetised, and to the electrical behaviour of selenium under the influence of light. He has delivered many lectures upon scientific subjects in London and elsewhere, and has several times had the honour of addressing audiences at the Royal and London Institutions. Has served upon the Councils of the Institution of Electrical Engineers (then the Society of Telegraph Engineers) and the Physical Society, of which latter he was for some years a vice-president. He was elected a Fellow of the Royal Society in 1886. He was an original director of the old Edison Electric Light Company, and when that company was amalgamated with the Swan, was invited to a seat on the board of the Edison-Swan United Company, a post which he still holds.

Johnson, W. Claude, M.I.C.E., at the age of seventeen was articled to Mr. W. F. Gooch, C.E., serving five years' apprenticeship in the locomotive works of the Vulcan Foundry, after which he studied at King's College, London. From 1869 to 1875 he was with the Telegraph Construction and Maintenance Company, and acted in various capacities both at the works and in cable-laying expeditions. Here he became thoroughly conversant with the requirements of cable laying and picking up; indeed, so close was his study of the subject that he soon became recognised as the leading authority dealing with such apparatus. Hence, when in 1875 he joined Mr. S. E. Phillips, to form the firm of Johnson and Phillips, that firm took a commanding position in the manufacture of all cable apparatus, and from that time to this the firm has probably designed, or, we should say, Mr. Claude Johnson has designed, and the firm constructed, the largest part of the cable machinery existing. Mr. Claude Johnson controls Charlton Works, which have steadily increased in size, and are still being added to. These works now cover an area of seven acres, and employ about 500 men. Latterly, the developments of electric lighting have overshadowed those of cable work, and the larger part of the works is devoted to lighting requirements, although just at present they are busy with cable machines designed for M. Grammont's factory in France, and other work for the Eastern Telegraph Company. It speaks much for the capacity of Mr. Claude Johnson as an engineer and as an organiser to see the admirable way in which these works are conducted. He has had the great advantage of being well supported by his scientific partner, Mr. S. E. Phillips. Literary and professional men are generally supposed to owe much to having sat at the feet of some Gamaliel, till it seems a pity that it was not fashionable for a successful business man to be surrounded with a bevy of learners. Of this firm it might be said that it pursues the only true course to ensure permanent success: it undertakes nothing it cannot perform, and is satisfied with none but the very best workmanship and materials. This speaks volumes for the heads and hearts that guide the venture.

Swinton, A. A. Campbell, was born in Edinburgh in 1863, and became in 1882 a pupil to Messrs. Sir W. G. Armstrong, Mitchell, and Co., at their Elswick works. In 1884 he succeeded to the position of electrical engineer to the company, and in this capacity carried out the electric lighting of all the war vessels built at Elswick up to 1887. During this period he introduced the system of wiring ships with lead-coated cable, since adopted by the English Admiralty, the first vessel to be wired exclusively on this principle being the Japanese cruiser "Naniwa Kan." In 1887 Mr. Swinton left Newcastle to take up his residence in London, retaining, however, the appointment of electrical adviser to Messrs. Armstrong, which he still holds. Since that date numerous electric light installations have been installed under his superintendence, among the more important of which may be mentioned those at New Scotland Yard for the Metropolitan Police, where there are nearly 1,200 lights; at Lambton Castle, for the Earl of Durham; at Wynyard Park, for the Marquis of Londonderry; at Sunningdale Park, for Major W. J. Joicey; at Hatchlands, for Mr. Stuart Rendle, M.P.; and at Moy Hall, for the Mackintosh of Mackintosh. He is also, by appointment of the Secretary of State, consulting electrical engineer to the Metropolitan Police, and has taken some part in connection with the reorganised New Telephone Company recently brought out by Messrs. Rothschild. Besides being the author of a number of articles on scientific subjects in the daily and periodic press, Mr. Swinton has written two books on electric lighting—"The Principles and Practice of Electric Lighting," published in 1884, and "The Elementary Principles of Electric Lighting," first published in 1886, which has run to two editions. He also exhibited a number of curious photographs of electric discharges at the last *conversazione* of the Royal Society, and is reading a paper on the subject of these photographs at the Edinburgh meeting of the British Association. Mr. Swinton, who is an associate member of the Institution of Civil Engineers, and a member of the Institution of Electrical Engineers, is also London representative of Messrs. C. A. Parsons and Co., of Newcastle-on-Tyne, manufacturers of the Hon. Charles Parsons's well-known steam turbines. Mr. Swinton has patented several improved forms of magneto-bell and telephone apparatus.

THE BRITISH ASSOCIATION.

The fifty-ninth meeting of the British Association was inaugurated at Edinburgh on Wednesday last by the presidential address of Sir Archibald Geikie. Although this address is of an exceedingly interesting character, it deals almost exclusively with geological questions, which are altogether outside the sphere of our labours. Sir Archibald Geikie called attention to a remarkable group of men who a century ago were discussing the great problem of the history of the earth, amongst whom James Hutton stands conspicuously. His famous theory of the earth was perhaps the germ of all modern views in that direction, and it was with the Hutton theory that the presidential address dealt. Those of our readers who are interested in the subject will no doubt be able to read this address elsewhere.

More closely connected with the subject which it is our special province to discuss are the presidential addresses in the Physical Section and in the Mechanical Section, or as they are known to the *habitués* of the association, Section A and Section G. These addresses were delivered by the respective presidents on Thursday as follows:

Address to the Mathematical and Physical Section

BY PROF. ARTHUR SCHUSTER, PH.D., F.R.S., F.R.A.S., PRESIDENT OF THE SECTION.

In opening the proceedings of our annual meeting the temptation is great to look back on the year which has passed and to select for special consideration such work published during its course as may seem to be of the greatest importance. I fear, however, that a year is too short a time to allow us to form a fair estimate of the value of a scientific investigation. The mushroom, which shoots up quickly, only to disappear again, impresses us more than the slow growing seedling which will live to be a tree, and it is difficult to recognise the scientific fungus in its early stage. But, although I do not feel competent to give you a review of the progress made in our subject during the last 12 months, there is one event to which some allusion should be made. It has been the sad duty of many of my predecessors to announce the death of successful workers in the field of science, but I believe I am unique in having the pleasure of recording the birth of a scientific man. At the beginning of this year there came into the world a being so [illegible] that he could, without preparation, take up the work of the most eminent man amongst us. Believers in the transmigration of souls have speculated on the fact that Galileo's death and Newton's birth fell within a year of each other; but no event has ever happened so striking as that which took place on the 1st of January, when the mantle of Sir William Thomson fell on the infant Lord Kelvin. Those who have attended these meetings will feel with me that the honour done to our foremost representative, an honour which has been a source of pride and satisfaction

to every student of science, could not altogether remain unnoticed in the section which owes him so much.

We are chiefly concerned here with the increase of scientific knowledge, and we derive pleasure in contrasting the minor state of ignorance of our own time with that which prevailed a hundred years ago. But when we contrast at the same time the refined opportunities of a modern research laboratory with the crude conditions under which the experimentalist had to work at the beginning of the century, we may fairly ask ourselves whether it is possible by means of any systematic course of study or by means of any organisation to accelerate our progress into the dark continent of science. A number of serious considerations arise in connection with this subject, and though I am not going to weary you by attempting an exhaustive discussion, I should like to draw your attention to a few matters which seem to me to be well worthy of the consideration of this association. Changes are constantly made and proposed in our existing institutions, or new ones are suggested which are to serve the purpose of a more rapid accumulation of knowledge. I need only allude to the alterations in the curriculum of the science schools in our old universities, made partly for the purpose of fitting their graduates for the conduct of original research, or to the national laboratory proposed by my predecessor in this chair for carrying out a certain kind of scientific investigation which at present is left undone, or is done by private enterprise. Even our own association has not escaped the evil eye of the reformer, and, like other institutions, it may be capable of improvement. But in choosing the direction in which a change may best be made, I think we may learn something from the way in which Nature improves its organisms. We are taught by biologists that natural selection acts by developing those qualities which enable each species best to survive the struggle for existence. Useless organs die off or become rudimentary. Nature teaches us, therefore, how a beautiful complex of beings, mutually dependent on each other, is formed by improving those parts which are best and most useful and letting the rest take care of itself. But in many of the changes which have been made or are proposed, the process of reform is very different. The weakest points are selected, our attention is drawn to some failure or something in which we are excelled by other nations, and attempts are made to cure what perhaps had better be left to become rudimentary. The proceeding is not objectionable as long as the nourishment which is applied to develop the weaker organs is not taken from those parts which we should specially take care to preserve. To apply these reflections to the question with which we are specially concerned, I should like to see it more generally recognised that although there is no struggle for existence between different nations, yet each nation, owing to a number of circumstances, possesses its own peculiarities, which render it better fitted than its neighbours to do some particular part of the work on which the progress of science depends. No country, for instance, has rivalled France in the domain of accurate measurement, with which the names of Regnault and Amagat are associated, and the International Bureau of Weights and Measures has its fitting home in Paris.* The best work of the German universities seems to me to consist in the following up of some theory to its logical conclusions and submitting it to the test of experiment. I doubt whether the efforts to transplant the research work of German universities into this country will prove successful. Does it not seem well to let each country take that share of work for which the natural growth of its character and its educational establishment best adapt it? Is it wise to remedy some weak point, to fill up undoubted gaps, if the soil that fills the gaps has to be taken from the hills and elevations which rise above the surrounding level?

As far as the work of this section is concerned, the strongest domain of this country has been that of mathematical physics. But it is not to this that I wish specially to refer. Look at the work done in Great Britain during the last two centuries; the work not only in physics, but in astronomy, chemistry, biology. Is it not true that the one distinctive feature which separates this from all other countries in the world is the prominent part played by the scientific amateur, and is it not also true that our modern system of education tends to destroy the amateur? By amateur, I do not necessarily mean a man who has other occupations and only takes up science in his leisure hours, but rather one who has had no academical training, at any rate in that branch of knowledge which he finally selects for study. He has probably been brought up for some profession unconnected with science, and only begins his study when his mind is sufficiently developed to form an entirely unbiassed opinion. We may, perhaps, best define an amateur as one who learns his science as he wants it and when he wants it. I should call Faraday an amateur. He would have been impossible in another country; perhaps he would be impossible in the days of the Science and Art Department. Other names will occur to you, the most typical and eminent being that of Joule. It is not my purpose to discuss why distinguished amateurs have been so numerous in this country, but I am anxious to point out that we are in danger of losing one great and necessary factor in the origination of scientific ideas.

One of the distinctive features of an amateur is this, that he carries not the weight of theories, often not the weight of knowledge, and, if I am right, there is a distinct advantage in having one section of scientific men beginning their work untrammelled by preconceived notions, which a systematic training in science is bound to instil. Whatever is taught in early age must necessarily be taught in a more or less dogmatic manner, and in whatever way it is taught, experience shows that it is nearly always received in a dogmatic spirit. It seems important, therefore, to confine the early training to those subjects in which preconceived notions are considered an advantage. It is to me an uncongenial task to sound a note of warning to our old universities, for the chief difficulties in which they are placed at present are due to the fact that they have given way too much to outside advice; but I cannot help expressing a strong conviction that their highly specialised entrance examinations are a curse to all sound school education, and will prove a still more fatal curse to what concerns us most nearly, the progress of scientific knowledge. If school examinations could be more general, if scientific theories could only be taught at an age when a man is able to form an independent judgment, there might be some hope of retaining that originality of ideas which has been a distinctive feature of this country, and enabled our amateurs to hold a prominent position in the history of science. At present a knowledge of scientific theories seems to me to kill all knowledge of scientific facts. It is by no means true that a complete knowledge of everything that has a bearing on a particular subject is always necessary to success in an original investigation. In many cases such knowledge is essential, in others it is a hindrance. Different types of men incline to different types of research, and it is well to preserve the dual struggle. The engine which works out the great problem of Nature may be likened to a thermo-dynamic machine. The amateur supplies the steam and the universities supply the cold water; the former, boiling over often with ill-considered and fanciful ideas, does not like the icy douche, and the professional scientist does not like the latent heat of the condensing steam, but nevertheless the hotter the steam and the colder the water the better works the machine. Sometimes it happens that boiler and cooler are both contained in the same brain, and each country can boast of a few such in a century, but most of us have to remain satisfied with forming only an incomplete part of the engine of research. But while it is necessary to recognise the great work done by the unprofessional scientists, it seems not untimely to draw their attention to the damage done to themselves if they overstep their legitimate boundaries, and especially if they seek popular support for their theories, which have not received the approval of those who are competent to judge. An appeal from Alexander sober to Alexander drunk will not prove successful in the end. The gradual disappearance of the amateur may be a necessary consequence of our increased educational facilities, and we must enquire whether any marked advantages are offered to us in exchange. There is one direction in which it would seem at first sight, at any rate, that a proper course of study could do much to facilitate the progress of research.

On another occasion I pointed out that two parties are necessary for every advance in science—the one that makes it, and the one that believes in it. If the discoverer is born, and cannot be made, would it not be possible at any rate to train the judgment of our students so that they may form a sound opinion on the new theories and ideas which are presented to them? It is too early as yet to judge in how far our generation is better in this respect than the one that has gone before them, but on closer examination it does not seem to me to be obvious that any marked improvement is possible. Every new idea revolutionising our opinions on some important question must necessarily take time before it takes a proper hold on the scientific world. Is it not true that anyone who can at once see the full importance of a new theory, and accept it in place of the one in which he has been brought up, must stand at a height almost equal to that of the originator? The more startling and fresh the new conception, the fewer must be those who are ready to adopt it. But looking back at the history of science during the present century, is there much evidence that great discoveries have been seriously delayed by want of proper appreciation? We may hear of cases where important papers have been rejected by scientific societies, and occasionally a man of novel ideas may have been too much neglected by his contemporaries. I doubt whether such cases of apparent injustice can ever be avoided, and simply looking back on the great changes involved in matters of primary importance, such as the undulatory theory of light, the conservation of energy, and the second law of thermo-dynamics, I cannot admit that there is much reason to be dissatisfied with the rate at which new theories have been received. Those who experience a temporary check, owing to the fact that public opinion is not ripe for their ideas, are often amply rewarded after the lapse of a few years. The disappointment which Joule may have felt during the time his views met with adverse criticism from the official world of science was no doubt amply compensated by the pleasure with which he watched the subsequent progress of research in the new domain which his discoveries have opened out. The point is not one of academic interest only, for the fear of repressing some important new discovery has a detrimental influence in another direction. The judgment of the scientific world seems to me to be tending too much towards leniency to apparently absurd theories, because there is a remote chance that they may contain some germ of real value. A new truth will not be found to suffer ultimately by adverse and even unreasonable criticism, while bad theories and bad reasoning, supported by the benevolent neutrality of those to whose judgment the scientific world looks for guidance, are harmful in many ways. They block the way to an independent advance and encourage hasty and ill-considered generalisations. The conclusion I should draw from the considerations I have placed before you are these. I believe that a reasonable censorship exercised by

* Much of the good work done by this bureau remains unknown, owing to the miserly way in which their publications are circulated. No copies are supplied even to the university libraries. The explanation, of course, is "want of funds." In other words, England, France, and Germany, together with other nations, unite to do a certain kind of work, but cannot afford to distribute a few copies of the publication to the public for whose benefit the work is undertaken.

our scientific societies is good and necessary; that those whose fate it is to be called on to express an opinion on some work or theory should do so fearlessly according to their best judgment. Their opinion may be warped by prejudice, but I think it is better that they should incur the risk of being ultimately found to be wrong than that they should help in the propagation of bad reasoning. There is one matter, however, on which all opinions must agree. Worse than bad theory or logic is bad experimental work. Should we then not rigorously preserve any influence or incentive which encourages the beginner to avoid carelessness and to consider neither time nor trouble to secure accuracy? There is no doubt to my mind that the prospect of admission to the Royal Society has been most beneficial in this respect, and that the honourable ambition to see his paper published in the *Transactions* of that society has preserved many a student from the premature publication of unfinished work.

One of the principal obstacles to the rapid diffusion of a new idea lies in the difficulty of finding suitable expressions to convey its essential point to other minds. Words may have to be strained into a new sense, and scientific controversies constantly resolve themselves into differences about the meaning of words. On the other hand, a happy nomenclature has sometimes been more powerful than rigorous logic in allowing a new train of thought to be quickly and generally accepted. A good example is furnished by the history of the science of energy. The principle of the conservation of energy has undoubtedly gained a more rapid and general acceptance than it would otherwise have had by the introduction of the word potential energy. A great theorem, which in itself seems to me to be an intricate one, has been simplified by calling something energy which, in the first place, is only a deficiency of kinetic energy. The only record I can find on the history of the expression is given in Tait's "Thermodynamics," wherein the term statical energy is ascribed to Lord Kelvin, and that of potential energy to Rankine. It would be of interest to have a more detailed account on the origin of an expression which has undoubtedly had a marked influence not only on the physics, but also on the metaphysics of our time. But while fully recognising the very great advantage we have derived from this term "potential energy," we ought not, at the same time, to lose sight of the fact that it implies something more than can be said to be proved. It is easy to overstep the legitimate use of the word. Thus, when Prof. Lodge* attempts to prove that action at a distance is not consistent with the doctrine of energy, he cannot, in my opinion, justify his opinion except by assuming that all energy is ultimately kinetic. That is a plausible but by no means a necessary theory. Efforts have been made to look on energy as on something which can be labelled and identified through its various transformations. Thus we may feel a certain bit of energy radiating from a coal fire, and if our knowledge was complete we ought to be able to fix the time at which that identical bit of energy left the sun and arrived on the surface of the earth, setting up a chemical action in the leaves of the plant from which the coal has been derived. If we push this view to a logical conclusion, it seems to me that we must finally arrive at an atomic conception of energy which some may consider an absurdity. Let, for instance, a number of articles, P_1, P_2, etc., in succession, strike another particle, Q. How can we in the translatory energy of the latter identify the parts which P_1, P_2, etc., have contributed? According to Prof. Lodge's view, we should be able to do so, for if the particle, Q, in its turn gives up its energy to others—say, R_1, R_2, R_3, etc.—we ought to be able to say whether the energy of P_1 has ultimately gone into R_1 or into R_2, or is divided between them. It is only by imagining that all energy is made up of a finite number of bits, which pass from one body to another, that we can defend the idea of considering energy as being capable of being "labelled."

In the expressions we adopt to describe physical phenomena we necessarily hover between two extremes. We either have to choose a word which implies more than we can prove, or we have to use vague and general terms which hide the essential point, instead of bringing it out. The history of electrical theories furnishes a good example. The terms positive and negative electricity committed us to something definite; we could reckon about quantities of electricity, and form some definite notion of electrical currents as a motion of the two kinds of electricity in opposite directions. Now we have changed all that; we speak of electric displacements, but safeguard ourselves by saying that a displacement only means a vector quantity, and not necessarily an actual displacement. We speak of lines and tubes of force not only as a help to realise more clearly certain analytical results, but as implying a physical theory to which, at the same time, we do not wish to commit ourselves. I do not find any fault with this, for it is a perfectly legitimate and necessary process to state the known connection between physical phenomena in some form which introduces the smallest number of assumptions. But the great question, "What is electricity?" is not touched by these general considerations. The brilliant success with which Maxwell's investigations have been crowned is apt to make us overrate the progress made in the solution of that question. Maxwell and his followers have proved the important fact that optical and electrical actions are transmitted through the same medium. We may be said to have arrived in the subject of electricity at the stage in which optics was placed before Young and Fresnel hit on the idea of transverse vibrations, but there is no theory of electricity in the sense in which there is an elastic solid theory of light. If the term electrical displacement was taken in its literal sense, it would mean that the electric current consists of the motion of the ether through the conductor. This is a plausible hypothesis, and one respecting which we may obtain experimental evidence. The experiments of Rayleigh and others have shown that the velocity of light in an electrolyte through which an electric current is passing, is, within experimental limits, the same with and against the current. This result shows that if an electrical current means a motion of the ether the velocity of the medium cannot exceed 10 metres a second for a current density of one ampere per square centimetre. This, then, is the upper limit for a possible velocity of the medium. Can we find a lower limit? The answer to that question depends on the interpretation of a well-known experiment of Fizeau, who found that the speed of light is increased if it travels through water which moves in the same direction as the light. If this experiment implies that the water carries the ether with it, and if a motion of the ether means an electric current, we should be led to the conclusion that a current of water should deflect a magnet in its neighbourhood. An experiment made to that effect would almost certainly give a negative result, and would give us a lower limit for the velocity of the medium corresponding to a given current. Such an experiment, together with that of Rayleigh, would probably dispose of the theory that an electric current is due to a translatory velocity of the medium. This would be an important step, and it would be worth while to arrive at a final settlement of the question.* The whole question of the relation between the motion of matter and motion of the medium is a vital one, and we shall probably not make any serious advances until experiment has found a new opening. But we must expect many negative results before some clue is discovered. Nor can we attach much importance to negative results unless they are made by someone in whose care and judgment we place full [illegible]. We should all the more, therefore, recognise the courage and perseverance of those who spend their valuable time in such investigations as Prof. Lodge has recently undertaken. That ultimately some relation will be found between moving matter and [illegible] action there is no reasonable doubt.

One of the most hopeful openings for new investigations [illegible] always been found in the pursuing of a theory to its logical conclusions, and there is one result of the electromagnetic [illegible] light, which has not, in my opinion, received the share of [illegible] which it deserves. When sound passes through air it [illegible] gated more quickly with the wind than against it, and we [illegible] easily find the velocity relative to the earth by combining the ordinary sound velocity with the velocity of the wind. [illegible] when any waves pass through a medium moving with [illegible] velocity, the waves being due to internal stresses in the medium, we may treat of the velocity of the waves [illegible] dently of that of the medium, and say that the wave [illegible] in the direction of motion of the medium, and relative [illegible] fixed body, is the sum of the wave velocity calculated [illegible] supposition that the medium is at rest and the velocity of the medium. Prof. J. J. Thomson,† applying Maxwell's equations, [illegible] arrived at a different result for electromagnetic waves, and [illegible] come to the conclusion that in order to get the velocity of [illegible] along a stream of flowing water we have to add to the velocity of light only half the velocity of water. The following considerations suggest themselves to me with respect to this result. Maxwell's theory is founded on certain observed effects, which all depend [illegible] the relative motion of matter. A result such as the one [illegible] to implies actions depending on absolute motion, and [illegible] therefore to point to something which has been introduced [illegible] the equations for which there is no experimental evidence. The only assumption clearly put down by Maxwell is that [illegible] magnetic actions are transmitted through the medium, [illegible] is possible that that assumption necessarily carries [illegible] J. J. Thomson's result with it. If a careful examination [illegible] the subject should show that this is the case, we are [illegible] face to face with a serious difficulty. It is said with [illegible] to be one of the great advantages of Maxwell's theory [illegible] does away with action at a distance; but what do we [illegible] replace action at a distance by something infinitely more [illegible] to conceive—namely, internal stresses of a medium depending [illegible] the velocity of the medium through space? I can only [illegible] loophole through which to escape—namely, that Maxwell's [illegible] is not homogeneous, but consists of two parts, and that if we [illegible] of the medium as moving, we mean the motion of one of these parts relative to the other.

While we may hope to obtain important results from an investigation of the relation between what we call electricity and the medium, we must not lose sight of another avenue [illegible] relation between electricity and chemical effects. The passage of electricity through gases presents us with a complicated [illegible] to which a number of physicists have given their attention [illegible] years. There seems no reasonable doubt that electricity in a gas is conveyed by the diffusion of particles conveying high charges, probably identical with those carried by the electrolytic [illegible]. The fact that this convection is a process of diffusion with [illegible] tively small velocity is shown by the experimental result [illegible] path of the discharge is affected by any bodily motion of [illegible] which conveys the current. Even the convection currents [illegible] the heat produced by the discharge itself are sufficient to [illegible]

* *Phil. Mag.*, vol. xl., p. 38 (1881).

* Fizeau's result must either be due to the motion of [illegible] through the medium or to the fact that moving matter [illegible] ether with it. If it is due to the former cause, and [illegible] not carry the ether with it, may we not consider that matter [illegible] through the ether, that is a relative motion of matter and [illegible] must produce effects equal and opposite to those of ether [illegible] through matter? In that case the reasoning in the [illegible] *mutatis mutandis*, hold good.

† *Phil. Mag.*, vol. ix, p. 284 (1880).

the luminous column which marks the passage of the current. The most puzzling fact, however, connected with the discharge of electricity through gases consists in the absence of symmetry at the positive and negative poles. There must be some difference between a positively and negatively charged atom which seems of fundamental importance in the relation between matter and what we call electricity. A discussion of the various phenomena attending the discharge of electricity through gases seems to me to point to a conclusion which may possibly prove a step in the right direction. A surface of separation between bodies having different conductivities becomes electrified by the passage of a current, while at the surface between two chemically distinct bodies we have, according to Helmholtz, a sheet covered at the two sides with opposite electricities. These surface electrifications are not merely imaginary layers invented to satisfy mathematical surface conditions. They can be proved to be realities. Thus, when one electrolyte floats on another, the specific resistances being different, we often observe secondary chemical effects due to the action of the ions which carry the surface electrification. If the passage of electricity from the solid to the gas involves some work done, we must expect a double sheet of electricity at the boundary, the gas in contact with the cathode becoming positively, and that in contact with the anode negatively, electrified. *A priori* we can form no idea how a layer of gas, the atoms of which carry charges, will behave. The ordinary proof that all electrification must be confined to the surface implies that all forces act according to the law of the inverse square, but where we have also to consider molecular forces, I see no reason why the electrification at a surface may not stretch across a layer having a thickness comparable with the mean free path of the molecule. It is here that there seems to be the fundamental difference between positive and negative electricity. A negative electrification of the gas, like that of a solid or a liquid, seems always confined to the surface, and no one has ever observed a volume electrification of negative electricity. The case is different for the positively electrified part of the gas. Wherever from other considerations we should expect a positively electrified surface sheet, we always get a layer of finite thickness. The result implies a different law of impact between positively and negatively electrified ions, but I see no inherent improbability in this. That the cathode let into a gas is surrounded by a positively electrified layer of finite thickness extending outwards must be considered as an established fact, and several of the characteristic features of the discharge are explained by it. The large fall of potential at the cathode can also be explained on the view which I have put forward, for in order to keep up the discharge there must be a sufficient normal force at the surface, and if this force is not confined to the surface, but necessarily stretches across a finite layer, the fall of potential must be multiplied a great number of times. Similarly Goldstein has shown that some of the phenomena of the cathode are observed at every place at which the positive current flows from a wide to a narrow part of a column of gas. At such places we should expect a positive surface electrification, and here, again, the whole appearance tends to show that we are dealing with a positive volume electrification. No corresponding phenomena are observed when the current passes from the narrow to the wide part. The fact that in all cases experimented upon positive volume electrifications are observed, but never similar negative electrifications, is surely of significance.

Some of the results recently brought to light by investigations on the discharge of electricity have interesting cosmical applications. Thus it is found that such a discharge through any part of a vessel containing a gas converts the whole gas into a conductor.* The dissociation which we imagine to take place in a liquid before electrolytic conduction takes place must be artificially produced in a gas by the discharge itself. We may imitate in gases which have thus been rendered conductive many of the phenomena hitherto restricted to liquids; thus I hope to bring to the notice of this meeting cases of primary and secondary cells in which the electrolyte is a gas. There are other ways in which a gas can be put into that sensitive state in which we may treat it as a conductor, and we have every reason to suppose that the upper regions of our atmosphere are in this state. The principal part of the daily variation of the magnetic needle is due to causes lying outside the surface of the earth, and is in all probability only an electromagnetic effect due to that bodily motion in our atmosphere which shows itself in the diurnal changes of the barometer. A favourite idea of the late Prof. Balfour Stewart will thus probably be confirmed. The difference in the diurnal range between times of maximum and times of minimum sun-spots is accounted for by the fact that the atmosphere is a better conductor at times of maximum sun-spots. The mention of sun-spots raises a point not altogether new to this section. Careful observations of celestial phenomena may suggest to us the solution of many mysteries which are now puzzling us. Consider, for instance, how long it would have taken to prove the universal property of gravitational attraction if the record of planetary motion had not come to the philosopher's help. And surely the most casual observation of cosmical effects teaches us how much we have yet to learn.

The statement of a problem occasionally helps to clear it up, and I may be allowed, therefore, to put before you some questions, the solution of which seems not beyond the reach of our powers.

1. Is every large rotating mass a magnet? If it is, the sun must be a powerful magnet. The comets' tails, which eclipse observations show stretching out from our sun in all directions, probably consist of electric discharges. The effect of a magnet on the discharge is known, and careful investigations of the streamers of the solar corona ought to give an answer to the question which I have put.*

2. Is there sufficient matter in interplanetary space to make it a conductor of electricity? I believe the evidence to be in favour of that view. But the conductivity can only be small, for otherwise the earth would gradually set itself to revolve about its magnetic pole. Suppose the electric resistance of interplanetary space to be so great that no appreciable change in the earth's axis of rotation could have taken place within historical times, is it not possible that the currents induced in planetary space by the earth's revolution may, by their electromagnetic action, cause the secular variation of terrestrial magnetism? There seems to me to be here a definite question capable of a definite answer, and as far as I can judge without a strict mathematical investigation the answer is in the affirmative.

3. What is a sun spot? It is, I believe, generally assumed that it is analogous to one of our cyclones. The general appearance of a sun spot does not show any marked cyclonic motion, though what we see is really determined by the distribution of temperature and not by the lines of flow. But a number of cyclones clustering together like the sun-spots in a group should move round each other in a definite way, and it seems to me that the close study of the relative positions of a group of spots should give decisive evidence for or against the cyclone theory.

4. If the spot is not due to cyclonic motion, is it not possible that electric discharges setting out from the sun, and accelerating artificially evaporation at the sun's surface, might cool those parts from which the discharge starts, and thus produce a sun spot? The effects of electric discharges on matters of solar physics have already been discussed by Dr. Huggins.

5. May not the periodicity of sun-spots, and the connection between two such dissimilar phenomena as spots on the sun and magnetic disturbances on the earth, be due to a periodically recurring increase in the electric conductivity of the parts of space surrounding the sun? Such an increase of conductivity might be produced by meteoric matter circulating round the sun.

6. What causes the anomalous law of rotation of the solar photosphere? It has long been known that groups of spots at the solar equator perform their revolution in a shorter time than those in a higher latitude; but spots are disturbances which may have their own proper motions. Dunér has shown, however, from the displacement of the Fraunhofer lines, that the whole of the layer which produces these lines follows the same anomalous law, the angular velocity at a latitude of 75deg. being 30 per cent. less than near the equator.‡ As all causes acting within the sun might cause the angular velocity of the sun to be smaller at the equator than at other latitudes, but could not make it greater, the only explanation open to us is an outside effect either by an influx of meteoric matter, as suggested by Lord Kelvin, or in some other way. If we are to trust Dr. Welsing's result that faculæ which have their seat below the photosphere revolve in all latitudes with the same velocity, which is that of the spot velocity in the equatorial region, we should have to find a cause for a retardation in higher latitudes rather than for an acceleration at the equator. The exceptional behaviour of the solar surface seems to me to deserve very careful attention from solar physicists. Its explanation will probably carry with it that of many other phenomena.

In conclusion, I should like to return for an instant to the question whether it is possible by any means to render the progress of science more smooth and swift. If there is any truth in the idea that two types of mind are necessary, the one corresponding to the boiler and the other to the cooler of a steam engine, it must also be true that some place must be found where the two may bring their influence to bear on each other. I venture to think that no better ground can be chosen than that supplied by our meetings. We hear it said that the British Association has fulfilled its object: we are told that it was originally founded to create a general interest in scientific problems in the towns in which it meets, and now that popular lectures and popular literature are supposed to perform that work more satisfactorily, we are politely asked to commit the happy despatch. There is no need to go back to the original intention of those who have founded this institution, which has at any rate adapted itself sufficiently well to the altered circumstances to maintain a beneficial influence in scientific research. The free discussion which takes place in our sections, the interchange of ideas between men who during the rest of the year have occupied their minds, perhaps too much, with some special problem, the personal intercourse between those who are beginning their work with sanguine expectations, and those who have lost the first freshness of their enthusiasm, should surely one and all ensure a long prosperity to our meetings. If we cannot claim any longer to sow the seeds of scientific interest in the towns we visit, because the interest is established, we can at any rate assure those who so kindly offer us hospitality that they are helping powerfully in the promotion of the great object which we all have at heart.

* An experiment by Hittorf (*Wied. Ann.*, VII., p. 614) suggested the probability of this fact, which was proved independently by Arrhenius and myself.

* The efforts of Mr. Bigelow have a bearing on this point, also some remarks which I have made in a lecture before the Royal Institution (*Proc.* Roy. Inst., 1891), but nothing decisive can be asserted at present.

† "Oefvers af Kongl. Vetensk. Ak. Forhandl.," 47 (1890).

‡ Although the importance of M. Dunér's results would make an independent investigation desirable, the measurements of Mr. Crew, who by a much inferior method arrived at other results, cannot have much weight as compared with those of Dunér.

Address to the Mechanical Science Section.

BY W. CAWTHORNE UNWIN, F.R.S., M.I.C.E., PRESIDENT OF THE SECTION

By what process selection is made of a sectional president of the British Association is to me unknown. I may confess that it was pleasant to receive the request of the council to preside at the meetings of Section G, even though much of the pleasure was due to its unexpectedness. I ventured to believe I might accept the honour gratefully, trusting to your kindness to assist me in fulfilling its obligations. Amongst engineers there are many with greater claims than I have to such a position, and who could speak to you from a wider practical experience. Here, in Section G, I think it may be claimed that the profession of engineering owes much to some who from circumstances or natural bias have concerned themselves more with those scientific studies and experimental researches which are useful to the engineer, than with the actual carrying on of engineering operations. Here, at so short a distance from the university where Rankine and James Thomson laboured, I may venture to feel proud of being amongst those whose business it has been rather to investigate problems than to execute works.

The year just passed is not one unmemorable in the annals of engineering. By an effort remarkable for its rapidity, and as an example of organisation of labour, the broad gauge system has been extinguished. It has disappeared like some prehistoric mammoth, a large limbed organism, perfect for its purpose and created in a generous mood, but conquered in the struggle for existence by smaller but more active rivals. If we recognise that the great controversy of 50 years ago has at last been decided against Brunel, at least we ought to remember that the broad gauge system was one only of many original experiments, due to his genius and courage, experiments in every field of engineering, in bridge building, in locomotive design, in ship construction, the successes and failures of which have alike enlarged the knowledge of engineers and helped the progress of engineering. The past year has seen the completion of the magnificent scheme of water supply for Liverpool from the Vyrnwy, carried out from 1879 to 1885 by Mr. Hawksley and Mr. Deacon, and since then completed under the direction of the latter engineer. This is one of the largest and most striking of those works of municipal engineering rendered necessary by the growth of great city communities and made possible by their wealth and public spirit. For the supply of water to Liverpool, the largest artificial lake in Europe has been created in mid Wales by the construction across a mountain valley of a dam of cyclopean masonry, itself one of the most remarkable masonry works in the world. The lake contains an available supply of over 12,000 million gallons, its size having been determined not only to supply 40 million gallons daily for the increasing demand of Liverpool, but also to meet the necessity imposed by Parliament that an unprecedentedly large compensation, amounting to 10 million gallons daily and 50 million gallons additional on 32 days yearly, should be afforded to the Severn. The masonry dam, though a little less in height than some of the French dams, is of greater length. It is nearly double the length of the great dam at Verviers.* Although masonry dams were an old expedient of engineers, it is in quite recent times, and chiefly in consequence of the scientific investigations of French engineers, that they have been revived in engineering practice. Since the construction of the Vyrnwy dam, another very large dam, the Tansa dam, has been completed in Bombay. This dam has a length of two miles and a height of 118ft., and it is 100ft. thick at the base. The reservoir will supply 100 million gallons per day. In the United States a still greater work of the same kind has been commenced on the Croton river, in connection with the water supply of New York. This dam will have a length of 2,000ft., and a height of 285ft. Its greatest thickness will be 215ft. It will be very much the boldest work of its kind. Returning to the Liverpool supply, the water taken from the lake at the most suitable level into a straining tower provided with very complete hydraulic machinery, passes through the Hirnant tunnel, and thence by an aqueduct, partly consisting of rock tunnels, partly of pipes 39in. to 42in. in diameter, 68 miles in length, being the longest aqueduct yet constructed. The crossing of the Mersey by an aqueduct tunnel has proved the greatest engineering difficulty to be surmounted. The tunnel has been carried through layers of running sand, gravel and silt. At first slow progress was made, but later, by the adoption of the Greathead system of shield with air locks and air compressing machinery, as much as 57ft. of tunnel were driven and lined in one week. The whole work is now complete, and Liverpool has available an extra supply of very pure water, amounting to 40 million gallons daily. A scheme of water supply for Manchester from Lake Thirlmere in Westmoreland, on an equally large scale, is approaching completion. Birmingham is likely to carry out another work of the same kind, and London, at a greater distance from pure water sources, and under greater difficulties from the complexity of existing interests, has come to realise that, within 50 years, a population of 12½ millions will probably have to be provided for. To supply such a population, a volume of water is required ten times as great as the whole available supply from Lake Vyrnwy.

Here in Edinburgh one remembers that the birthplace of the steam engine is near at hand. A century and a quarter ago, James Watt made an invention which has profoundly influenced all the conditions of social, national, commercial, and industrial life. It is due to the steam engine more than to any other single cause that the population in this country has tripled since the beginning of the century, and that we have become dependent on steam power for fuel, for transport, for manufactures, in many cases for water supply, for sanitation, and for artificial light. From some German statistics it appears that there are probably now in the world, employed in industry, steam engines exerting 49 million horse power, besides locomotives exerting six million horse power. Engines in steamships are not included. The steam engine has become a potent factor in civilisation, because it places at our disposal mechanical energy at a sufficiently low cost, and the efforts of engineers have been steadily directed to diminishing the cost at which steam power is produced. Members of one great branch of our profession are much concerned in the production of mechanical energy at a sufficiently cheap rate. They require it in very large quantity for transformation into light and for retransformation into mechanical energy under conditions more convenient than the direct use of steam power. Perhaps it will not be inappropriate if in Section G, I first discuss briefly some of the causes which have made the steam engine inefficient and the extent to which we are getting to a scientific knowledge of the methods of evading them. I propose then to consider some of the methods of economising the cost and increasing the convenience of mechanical power by generating it at central stations and distributing it, and, lastly, how far means of transporting energy are likely to make available cheaper sources of energy than steam power. Let us go back for a moment to James Watt. The most distinct feature about the invention of the steam engine is that it arose out of studies of such questions as the relation of pressure and temperature of steam, the heat absorbed in producing it, and its volume at different pressures. Armed with this knowledge Watt was able to determine that the quantity of steam used in a model atmospheric engine was enormously greater than that due to the volume described by the piston. There was waste of steam. To discover the loss was to get on the path of finding a remedy. The separate condenser, by diminishing cylinder condensation, annulled a great part of the loss. So great was Watt's insight into the action of the engine that he was able to leave it so perfect that, except in one respect, little remained for succeeding engine builders, except to perfect the machines for its manufacture, to improve its details and to adapt it to new purposes. Now it very early became clear that there were two directions of advance which ought to secure greater economy. Simple mechanical indications showed that increased expansion ought to ensure increased economy. Thermo-dynamic considerations indicated that higher pressures, involving a greater temperature range of working, ought to secure greater economy. But in attempting to advance in either of these directions, engineers were more or less disappointed. Some of Watt's engines worked with 8lb. of coal per indicated horse power per hour. Many engines with greater pressures and longer expansions have done but little better. The history of steam engine improvement for a quarter of a century has been an attempt to secure the advantages of high pressures and high ratios of expansion. The difficulty to be overcome has proved to be due to the same cause as the inefficiency of Watt's model engine. The separate condenser diminished, but did not annul the action of the cylinder wall. The first experiments which really startled thoughtful steam engineers were those made by Mr. Isherwood between 1860 and 1865. Mr. Isherwood showed that in engines such as those then in use in the United States Navy, with the large cylinders and low speeds then prevalent, any expansion of the steam beyond three times led, not to an increased economy, but to an increased consumption of steam. Very little later than this M. Hirn undertook, in 1873-5, his classical researches on the action of the steam in an engine of about 150 i.h.p. Experiments of greater accuracy or completeness, or of greater insight into the conditions which were important, have never since been made, and Hirn with his assistants, MM. Hallauer and Dwelshauvers Dery, has determined, once for all, the whole method of a perfect steam engine trial. M. Hirn was the first to clearly realise that the indicator gives the means of determining the steam present in the cylinder during every period of the cycle of the engine. Consequently, superheating in ordinary cases being out of the question, we have the means of determining the heat present and the heat already converted into work. The heat delivered into the engine is known from boiler measurements, combined with calorimetric tests of the quality of the steam, tests which Hirn was the first to undertake. The balance of heat unaccounted for is, then, a waste or loss due to causes which have to be investigated. Hirn originated a complete method of analysing an engine test, showing at every stage of the operation the heat accounted for and a balance of heat unaccounted for, and the latter proved to be a very considerable quantity. Meanwhile theoretical writers, especially Rankine and Clausius, had been perfecting a thermo-dynamic theory of the steam engine based primarily on the remarkable and irrefragable principles of Carnot. The result of Hirn's analysis was to show that these theories applied to the actual steam engine, were liable to lead to errors of 50 or 60 per cent., the single false assumption being made that the interaction between the walls of the cylinder and the steam was an action small enough to be negligible.

In this country Mr. Mair Rumley, following Hirn's method, made a series of experiments on actual engines with great care and accuracy and completeness. All these experiments demonstrated the fact of a large initial condensation of steam on the walls of the cylinder, alike in jacketed and unjacketed engines. The condensed steam is re-evaporated partially during expansion, be-

* The length of the dam from rock to rock is 1,172ft. Height from lowest part of foundation to parapet of carriageway, 161ft. Height from bed of river to overflow sill, 84ft. Thickness of masonry at base, 120ft.

mainly during exhaust, and serves as a mere carrier of heat from boiler to condenser, in conditions not permitting its utilisation in producing work. It became clear from Hirn's experiments, if not from the earlier experiments of Isherwood, that for each engine there is a particular ratio of expansion for which the steam expenditure per horse-power is least. Prof. Dery has since deduced from them that the practical condition of securing the greatest efficiency is that the steam at release should be nearly dry. In producing that dryness the jacket has an important influence. In spite of much controversy amongst practical engineers about the use of the jacket, it does not appear that any trustworthy experiment has yet been adduced in which there was an actual loss of efficiency due to the jacket. In the older type of comparatively slow engines it is a rule that the greater the jacket condensation the greater the economy of steam, even when the jacket condensation approaches 20 per cent. of all the steam used. It appears, however, that as the speed of the engine increases, the influence of the jacket diminishes, so that for any engine there is a limit of speed at which the value of the jacket becomes insignificant.

Among steam engine experiments directed specifically to determine the action of the cylinder walls, those of the late Mr. Willans should be specially mentioned. Mr. Willans's death is to be deplored as a serious loss to the engineering profession. His steam engine experiments, some of them not yet published, are models of what careful experiments should be. They are graduated experiments designed to indicate the effect of changes in each of the practically variable conditions of working. They showed a much greater variation of steam consumption (from 40lb. to 18lb. per indicated horse-power hour) in different conditions of working than, I think, most practical engineers suspected, and this has been made more significant in later experiments on engines working with less than full load. The first series showed that in full load trials the compound was superior to the single engine in practically all the conditions tried, but that the triple was superior to the compound only when certain limits of pressure and speed were passed.

As early as 1878 Prof. Cotterill had shown that the action of a cylinder wall was essentially equivalent to that of a very thin metallic plate, following the temperature of the steam. The exceedingly rapid dissipation of heat from the surface during exhaust especially being due to the evaporation of a film of water initially condensed on its surface. In permanent *regime* the heat received in admission must be equal to that lost after cut off. In certain conditions it appeared that a tendency would arise to accumulate water on the cylinder surfaces, with the effect of increasing in certain cases the energy of heat dissipation. Recently Prof. Cotterill has been able to carry much further the analysis of the complex action of condensation and re-evaporation in the cylinder and to discriminate in some degree between the action of the metal and the more ambiguous action of the water film. By discarding the less important actions, Prof. Cotterill has found it possible to state a semi-empirical formula for cylinder condensation in certain restricted cases which very closely agree with experiments on a wide variety of engines. It is to be hoped that, with the data now accumulating, a considerable practical advance may be made in the clearing up of this complex subject. There are, no doubt, some people who are in the habit of depreciating quantitative investigations of this kind. They are as wise as if they recommended a manufacturer to carry on his business without attending to his account books. Further, the attempt to obtain any clear guidance from experiments on steam engines has proved a hopeless failure without help from the most careful scientific analysis. There is not a fundamental practical question about the thermal action of the steam engine, neither the action of jackets or of expansion or of multiple cylinders, as to which contradictory results have not been arrived at, by persons attempting to deduce results from the mass of engine tests without any clear scientific knowledge of the conditions which have affected particular results. In complex questions fundamental principles are essential in disentangling the results. Interpreted by what is already known of thermo-dynamic actions, there are very few trustworthy engine tests which do not fall into a perfectly intelligible order. There is only one known method, not now much used, by which the cylinder condensation can be directly combated. Thirty years ago superheating the steam was adopted with very considerable increase of economy. It is likely that it was thought by the inventor of superheating that an advantage would be gained by increasing the temperature range. If so, his theory was probably a mistaken one. For the cooling action of the cylinder is so great that the steam is reduced to saturation temperature before it has time to do work, but the economy due to superheating was unquestionable, and was very remarkable considering how small a quantity of heat is involved in superheating. The heat appears to diminish the cylinder wall action so much as almost to render a jacket unnecessary. The plan of superheating was abandoned from purely practical objections, the superheaters then constructed being dangerous. Recently superheating has been tried again at Mulhouse by M. Meunier, and his experiments are interesting because they are at higher pressures than in the older trials and with a compound engine. It appears that even when the superheater was heated by a separate fire there was an economy of steam of 25 to 30 per cent. and an economy of fuel of 20 to 25 per cent., and four boilers with superheating were as efficient as five without it. may be pointed out as a point of some practical importance that a trustworthy method of superheating could be found, the vantage of the triple over the compound engine would be much minished. For marine purposes the triple engine is perfectly apted. But for other purposes it is more costly than the compound engine, and it is less easily arranged to work efficiently with a varying load. There does not seem much prospect of exceeding the efficiency attained already in the best engines, though but few engines are really so efficient as they might be, and there are still plenty of engines so designed that they are exceedingly uneconomical. The very best engines use only from 12lb. to 13lb. of steam per indicated horse-power hour, having an absolute efficiency reckoned on the indicated power of 16 per cent., or reckoned on the effective power, 13 per cent. The efficiency, including the loss in the boiler, is only about 9 per cent. But there are internal furnace engines of the gas-engine or oil-engine type in which the thermal efficiency is double this.

In his interesting address to this section in 1878, Mr. Easton expressed the opinion that the question of water power was one deserving more consideration than it had lately received, and he pointed to the variation of volume of flow of streams as the principal objection to their larger utilisation. Since that time the progress made in systems of transporting and distributing power has given quite a new importance to the question of the utilisation of water power. There seems to be a probability that in many localities water power will, before long, be used on a quite unprecedented scale, and under conditions involving so great convenience and economy that it may involve a quite sensible movement of manufacturers towards districts where water power is available. If we go back to a period not very distant in the history of the world, to the middle of the last century, we reach the time when textile manufactures began to pass from the condition of purely domestic industries to that of a factory system. The fly shuttle was introduced in 1750, the spinning jenny was invented in 1767, and Crompton's machine only began to be generally used in 1787. It was soon found that the new machines were most suitably driven by a rotary motion, and after some attempts to drive them by horses, water power was generally resorted to. In an interesting pamphlet on the "Rise of the Cotton Trade," by John Kennedy of Ardwick Hall, written in 1815, it is pointed out that the necessity of locating the mills where water power was available had the disadvantages of taking them away from the places where skilled workmen were found, and from the markets for the manufactured goods. Nevertheless, Mr. Kennedy states that for some time after Arkwright's first mill was built at Cromford, all the principal mills were erected near river falls, no other power than water power having been found practically useful. "About 1790," says Mr. Kennedy, "Mr. Watt's steam engine began to be understood, and waterfalls became of less value. Instead of carrying the workpeople to the power, it was found preferable to place the power amongst the people." The whole tendency of the conditions created by the use of steam power has been to concentrate the industrial population in large communities, and to restrict manufacturing operations to large factories. Economy in the production of power, economy in superintendence, the convenience of the subdivision of labour, and the costliness of the machines employed, all favoured the growth of large factories. The whole social conditions of manufacturing centres have been profoundly influenced by these two conditions—that coal for raising steam can be easily brought to any place where it is wanted, and that steam power is more cheaply produced on a large scale than on a small scale. It looks rather, just now, as if facilities for distributing power will to some extent reverse this tendency. Let me first point out that water power, where it is available, is so much cheaper and more convenient than steam power that it has never been quite vanquished by steam power.

I find, from a report by Mr. Weissenbach, that, in 1876, 70,000 h.p. derived from waterfalls were used in manufacturing in Switzerland. According to a census in 1880, it appears that the total steam and water power employed in manufacturing operations in the United States was 3,400,000 h.p. Of this, 2,185,000 h.p., or 64 per cent., was derived from steam, and 1,225,000 h.p., or 36 per cent., from water. In the manufacture of cotton and woollen goods, of paper and of flour, 760,000 h.p. were obtained from water, and 515,000 h.p. from steam. If statistics could be obtained from other countries, I believe it would be found that a very large amount of water power is actually made available. The firm of Escher Wyss and Company, of Zurich, have constructed more than 1,800 turbines of an aggregate power of 111,460 h.p. With a very limited exception all the water power at present used is employed in the neighbourhood of the fall where it is generated. If means were available for transporting the power from the site of the fall to localities more convenient for manufactures, there can be no doubt that a much larger amount of water power would be used, and the relative importance of water and steam power in some countries would probably be reversed. It is because recent developments seem to make such a transport of power possible without excessive cost, and without excessive loss, that a most remarkable interest has been excited in the question of the utilisation of water power. Take the case of Switzerland, for instance. At the present time Switzerland is said to pay to other countries £800,000 annually for coal. But the total available water power of Switzerland is estimated at no less than 582,000 h.p., of which probably only 80,000 are at present utilised. I found a year ago that nearly every large industrial concern in Switzerland was preparing to make use of water power, transported a greater or less distance. Besides the great schemes actually carried out at Schaffhausen, Bellegarde, Geneva, and Zurich, where water power is already utilised on a very large scale, there is a project to develop 10,000 h.p. on the Dranse, near Martigny. Hence, it is easy to see that problems of distribution of power—that is, the transformation of energy into forms easily transportable and easily utilisable—have now a great interest for engineers. Besides the power required for manu-

facturing operations, there is a steadily increasing demand for easily available mechanical energy in large towns. For tramways, for lifts, for handling goods, for small industries, for electric lighting, and sometimes for sanitation, power is required. Hitherto steam engines, or more lately gas engines, have been used, placed near the work to be done. But this sporadic generation of power is uneconomical and costly, especially when the work is intermittent; the cost of superintendence is large, and the risk of accident considerable. Hence attention is being directed to systems in which the mechanical energy of fuel or falling water is first generated in large central stations, transformed into some form in which it is conveniently transportable and capable of being rendered available by simpler motors than steam engines.

Just as in great towns it has become necessary to supersede private means of water supply by a municipal supply; just as it has proved convenient to distribute coal gas for lighting and heating, and to provide a common system of sewerage, so it will probably be found convenient to have in all large towns some means of obtaining mechanical power in any desired quantity at a price proportionate to the quantity used, and in a form in which it can be rendered available, either directly or by simple motors requiring but little skilled superintendence.

Teledynamic Transmission.—First, then let me say a few words as to modes of distributing power which it is possible to adopt. In 1850, at Logelbach in Alsace, M. Ferdinand Hirn used a flat steel belt to transmit power directly a distance of 80 metres. Subsequently a wire rope was used on grooved pulleys. This worked so well that a second transmission to a distance of 240 metres was erected. The details of the system were worked out with great care with a view to securing the least cost of construction, the least waste of energy, and the greatest durability of the ropes. So successful did this system of teledynamic transmission prove that within 10 years M. Martin Stein, of Mulhouse, had erected 400 transmissions, conveying 4,200 h.p., and covering a distance of 72,000 metres. Just at this time a very able and far-seeing manufacturer at Schaffhausen, Herr Moser, had formed a project for reviving the failing industries of the town by utilising part of the water power of the Rhine. Hirn's system of wire-rope transmission rendered this project practicable. The works were commenced in 1863. Three turbines of 750 h.p. were erected on a fall which varies from 12ft. to 16ft., created by a weir across the river. From the turbines the power is transmitted by two cables, in one span of 392ft., across the river. Similar cables distribute the power to factories along the river bank. In 1870 the transmission extended to a distance of 3,400ft. Power is sold at rates varying from £5 to £6 per horse-power per annum. In 1887 there were 23 consumers of power paying a rental of £3,500 per annum for power. The project has been financially successful, and is still working. At Zurich, Freiberg, and Bellegarde there are similar installations, and a large scheme of the same kind has recently been carried out at Gokak in India. Wire-rope transmissions are of great mechanical simplicity, and the loss of power in transmission is exceedingly small. They are extremely suitable for certain cases where a moderate amount of power has to be transmitted a moderate distance, to one or to a few factories. On the other hand, they become cumbrous if the amount of power transmitted exceeds 600 h.p. or 1,000 h.p. The wear of the ropes, which only last a year, has proved greater than was expected, and is a source of considerable expense.

The practical introduction of a system of distributing power by pressure water is due to Lord Armstrong. Such a system involves a central pumping station, a series of distributing mains, and suitable working motors. From its first introduction the peculiar advantages of this system for driving intermittently working machines, such as lifts, dock machinery, railway cranes, and hauling gear, became obvious. But, with intermittent working machines, there arose the need of an appliance for storing energy during periods of minimum demand and restoring it in periods of maximum demand. The invention of the accumulator by Lord Armstrong made the system of hydraulic transmission a success, and at the same time fixed its character as a system specially adapted for those cases where intermittent work is required to be done. Lord Armstrong's system of hydraulic distribution by water at a pressure of 700lb. or 800lb. per square inch, with the use of accumulators for equalising the variations of supply and demand, has now been widely adopted. The most extensive scheme of that kind hitherto executed is the important scheme carried out by the Hydraulic Power Company. Over 50 miles of pressure mains have now been laid in the streets of London. The Falcon Wharf pumping station contains four sets of compound pumping engines, each of 200 h.p. Two additional pumping stations have now been erected, and 1,500 lifts are worked from the pressure mains. The minimum charge for water is 2s. per 1,000 gallons. This rate of charge is economical for such machines as lifts, but it would be extravagant for machines working continuously. It would be equivalent to a charge of nearly £50 per horse-power per year of 3,000 working hours, apart from interest and maintenance of machines.

I shall indicate later on that in some cases where local conditions are favourable, where there is cheap water power and the possibility of constructing high-level storage reservoirs, then hydraulic transmission can be adopted with success for distributing power for ordinary manufacturing purposes. But neither teledynamic transmission nor hydraulic transmission have proved suitable as methods for the general distribution of motive power from central stations. Distribution by steam and distribution by heated water have both been tried in the United States, but not with very remarkable success. Only two other methods are available, distribution by compressed air and distribution by electricity. For many years compressed air has been used to distribute power in tunnelling and mining operations to considerable distances. It is only recently that it has been used as a general method of distributing power to many consumers. In many installations the machinery has been rough and unscientific, and the waste of energy very considerable. It is through experience gained and improvements carried out in the remarkable system now at work in Paris, and known as the Popp system, that the great advantages of compressed air distribution have been proved. The Paris system has very gradually developed. About 1870 a small compressing station was erected to actuate public and private clocks by intermittent pulses of air conveyed along pipes chiefly laid in the sewers. In 1889 about 8,000 clocks were thus driven. Meanwhile the compressed air had also been applied to drive motors for small industries. The demand for power thus supplied grew so rapidly that a second compressing station was built in the Rue de Saint Fargeau. In 1889 steam air compressors of 2,000 h.p. were at work, and additional compressors were under construction. The pressure at that time was five atmospheres, and the largest air mains were 12in. in diameter. Ingenious and simple rotary machines were used as air motors for small powers, and for larger powers any ordinary steam engine was converted into an air motor. Prof. Kennedy made tests in 1889, which were communicated to this association. He found that a motor four miles from the compressing station indicated 10 h.p. for 20 i.h.p. expended at the compressing station, an efficiency of 50 per cent. only. There were then 225 motors worked from the air mains. Since 1889 more extended investigations have been made by Prof. Riedler, of Berlin, and the chief part of the waste of work has been traced to inefficiency of the air compressors. Compound air compressors of much higher efficiency have now been constructed. The plant at the St. Fargeau station has been increased to 4,000 h.p. A new station has been erected on the Quai de la Gare, intended ultimately to contain compressors of 24,000 h.p. Compressors of 10,000 h.p. are already under construction. Compressed air transmission, whether or not it is the most economical system, is undoubtedly applicable for the distribution of power on a very large scale and to very considerable distances. There is nothing in any of the appliances which is novel or imperfectly understood. The air is used in the consumer's premises in machinery of well-understood types, and old steam engines can be converted into air motors without difficulty and without alteration of existing transmissive machinery in the factories. Not least important, the air can be measured with accuracy enough for practical purposes by simple meters, and charged for in proportion to the power consumed. Air compressors and air motors are not as efficient as dynamos and electric motors, but in one respect distribution by air and electricity are similar. For distances which are not more than a few miles the loss of energy in transmission is small enough to be insignificant.

There is yet one other mode of power distribution which promises to become the most important of all, and which, in the case of transmission to very great distances, if such transmission becomes necessary, has undoubtedly great advantages over every other method.

About electrical distribution of power I shall not venture to say much, partly because I am not an electrical expert, partly because it has been lately pretty fully discussed. In the United States there has been an enormous development of electric tramways, which are essentially cases of electric power distribution. In this country we have the South London and some other railways worked electrically. There are others also on the Continent. But electrical power distribution to private consumers for industrial purposes has not yet made as much progress as might have been expected. Perhaps electrical engineers have been so busy with problems of electric lighting that they have had no time to settle the corresponding problems of power distribution. No doubt continuous-current distribution presents at the moment the fewest difficulties, or, at any rate, involves the fewest comparatively untried expedients. Some continuous-current plants for distributing power are in operation, of which, perhaps, the most interesting is that at Oyonnax, which was described in Section G last year by Prof. G. Forbes. There 300 h.p., obtained by turbines, is transmitted eight kilometres at 1,800 volts. It is then let down by motor transformers to a voltage suitable for lighting and driving motors. A number of small workshops are driven, the power being supplied at a low rent. At the Calumet and Hecla mines on Lake Superior, at the Dalmatia mines in California, and some other places, energy derived from turbines is transmitted distances of a mile or two by continuous electric currents and used in driving mining machinery, and some cases of the use of electrical distribution in this country were mentioned by my predecessor in his address last year. At Bradford a few electric motors are being worked from the electric lighting mains. The largest of these is of 20 h.p. The price at which the electricity is supplied is not given, but I believe the cost is high when reckoned for continuous working. It would seem that it must be so when the electric current is generated by steam power. At Schaffhausen an electric transmission has now been constructed alongside of the wire-rope transmission. The power is derived from two turbines, and is transmitted across the Rhine, a distance of 750 yards, at 624 volts. The current drives a spinning mill, in which the largest motor is 380 h.p. The power is sold, I believe, at £3 per horse-power of the motors per annum.

Many engineers have now apparently come to the conclusion that alternating currents will be better for power transmission to considerable distances than continuous currents. The interesting alternate-current transmission, partly for power, partly

for lighting purposes, has been for some time in operation at Genoa. On the line of the aqueduct bringing water from the Gorzente rivulet three electric stations are being established. The reservoirs are 2,050ft. above Genoa, and as this is a much greater fall than is required for water supply purposes, part can be used to generate about 1,600 h.p. In the first of the power stations erected there are turbines of 450 h.p. driving two dynamos. A second larger station was completed in November. In this there are eight alternate current dynamos of 70 h.p. each. Six alternators are worked in series, transmitting a current of 6,000 volts. The current is transmitted 16 miles by bare copper wires, 8.5 mm. diameter, placed overhead. The current is used both for lighting and power purposes. Another method of using alternating currents was adopted in the remarkable experiment at Frankfort last year. In that case energy obtained by turbines at Lauffen was transmitted to Frankfort, a distance of 108 miles, and used for lighting and driving a motor. The current was obtained at low tension, transformed up to a tension of 18,000 to 27,000 volts for transmission, and then transformed down again for distribution. The loss in the conducting wires ranged from 5 h.p. when the turbines worked at 100 h.p., to 25 h.p. when the turbines worked at 200 h.p. The efficiency of dynamo, two transformers, and line, ranged from 68 to 75 per cent., a remarkably satisfactory result. There can be little doubt that if efficient and durable transformers can be constructed, they do give a considerable advantage to an alternate-current system. To an ordinary engineer it appears also that the system of producing current at low tension in the dynamo, and using it at low tension in the motors, permits the construction of dynamos and motors more mechanically unexceptionable than those working at high voltage.

I have spoken of the growth of a demand for power distributed in a convenient form in towns. The power distribution in London, Manchester, Birmingham, and Liverpool by pressure water, and that by compressed air in Paris, shows how rapidly, when power is available, a demand for it arises. A striking instance may be found in the small town of Geneva. In 1871, soon after the completion of the earlier system of low pressure water supply, Colonel Turrettini applied to the Municipal Council to place a pressure engine on the town mains for driving the factory of the Society for Manufacturing Physical Instruments. The plan proved so convenient that nine years after, in 1880, there were in Geneva 111 water motors supplied from the low pressure mains, using 34,000,000 cubic feet of water annually, and paying to the municipality nearly £2,000 a year. The cost of the power was not low. It was charged at a rate equivalent to from £36 to £48 per horse-power per year of 3,000 working hours. But even the high price did not prevent the use of power so conveniently obtainable. Since then a high pressure water service has been established, the water being pumped by turbines in the Rhone. From this high-pressure service power is supplied more cheaply. On the high pressure system the cost of the power is about 0.7d. per horse-power hour, or £8 per horse-power for 3,000 working hours. In 1889 the annual income from water sold for power purposes on the low pressure system was £2,083, and on the high pressure system £4,500. On the high pressure system the receipts in 1889 were increasing at the rate of £880 per year. In 1889 the motive power distributed on the high pressure system alone amounted to 1,500,000 horse-power hours, there being 79 motors of an aggregate working power of 1,279 horses. In Zurich there is a quite similar system and power, amounting to 9,000,000 horse-power hours in the year, distributed hydraulically to various consumers who pay a rental of £1,200 per annum. It will be noted that all this power in Geneva and Zurich is obtained from water which has been pumped, and it is the low cost of the water power which does the pumping which makes this possible. But further, in both Geneva and Zurich the whole of the dynamos supplying electric light are also driven by turbines using pumped water. The convenience of this arises in this way. The fall obtainable in the river in both cases is a small one and varies. Large turbines are required, and these cannot work at a constant speed. Further, it is expensive to use these large low pressure turbines to drive directly dynamos which only work with a considerable load for a short portion of the day. The low pressure turbines in the river are therefore used to pump water to a high level reservoir, and they work with a constant load all the 24 hours. From the high level reservoir water is taken as power is required to drive the dynamos, and the turbines driving the dynamos are small high pressure turbines, working always on a constant fall at a regular speed and easily adjusted by a governor to a varying load. The system seems a roundabout one, but it is perfectly rational, effective, and economical.

Few persons can have seen Niagara Falls without reflecting on the enormous energy which is there continuously expended, and for any useful purpose wasted. The exceptional constancy of the volume of flow, the invariability of the levels, the depth of the plunge over the escarpment, the solid character of the rocks, all mark out Niagara as an ideally perfect water power station, while, on the other hand, the remarkable facilities of transport, both by ...eam navigation on the lakes and by four systems of railway, ...ford commercial advantages of the highest importance. From a ...chment basin of 240,000 square miles, an area greater than ...t of France, a volume of water amounting to 265,000 cubic feet ... second descends from Lake Erie to Lake Ontario, a vertical ...ance of 326ft., in 37½ miles. Supposing the whole stream could ...utilised, it would supply 7,000,000 h.p. This is more than ...uble the total steam and water power at present employed in ...nufacturing industry in the United States. Immediately ...ar the Falls the river bends at right angles, and flows ...ugh a narrow gorge. The town of Niagara Falls on the American side occupies the table-land in this angle. The earliest traders who settled near the Falls erected stream mills in the Upper River in 1725 for preparing timber. Later, the Porter family erected factories on the islands in the rapids above the Falls. It was not, however, till about 30 years ago that any systematic attempt was made to utilise part of the water power of the Falls. Then a canal was constructed from Port Day, about three-quarters of a mile above the Falls, to a forebay or head race along the cliff overlooking the lower river. In 1874 the Cataract Mill was established, taking power from this canal, and other mills were gradually erected till about 6,000 h.p. was utilised. These mills have been exceedingly prosperous, but since the growth of a feeling against the disfigurement of the Falls it has become impossible to extend works of the same kind. The idea of a method of utilising the Falls, capable of greater development, and free from the objections to the hydraulic canal with mills discharging tail water on the face of the cliff, is due to the late Mr. Thomas Evershed, division engineer of the New York State canals. He proposed to construct head race canals on unoccupied land some two miles above the Falls. From these the water was to fall through vertical turbine pits into tail race tunnels, converging into a great main tunnel, discharging into the lower river. Apart from an inappreciable diminution of the volume of flow over the Falls, this plan avoids any disfigurement of the scenery near the Falls, and permits a head of nearly 200ft. to be made available. It is, however, essential to such a plan that work should be undertaken on a very large scale. In 1886 the Niagara Falls Company was incorporated, and obtained options over a considerable area of land, extending from Port Day for two miles along the Niagara River. In 1889 the Cataract Construction Company was formed to mature and carry out the constructional works required. The present plans contemplate the utilisation of 100,000 effective horse-power. The principal work of construction is a great tunnel 7,250ft. long, which is to form a tail race to the turbines, starting from land belonging to the company, and discharging into the lower river. The tunnel is 19ft. by 21ft., or 386 square feet in area, inside a brickwork lining 16in. thick. The base of the tunnel is 205ft. below the sill of the head gate, and permits a fall of 140 to be rendered available at the turbines. The brickwork of the tunnel is lined for 200ft. from the mouth with cast-iron plates. The tunnel has been excavated with remarkable rapidity with the aid of drills worked by compressed air. The main head race, about 200ft. wide, will run for about 5,000ft., parallel with the river, having entrances from the river at both ends. Near the lower reach the Soo Paper Company is already arranging to utilise 6,000 h.p., discharging the water from the turbines through a lateral tunnel into the main tunnel. Near this lower reach will also be placed two principal power stations, from which power will be distributed, either electrically or otherwise in ways not yet fully determined. The first turbines to be erected in these power stations will be twin turbines of the outward flow type of 5,000 effective horse-power. These turbines have a vertical shaft for driving dynamos or other machinery placed above ground. According to Mr. Evershed's original plans it was intended to distribute water by surface canals to different power users, each of whom would sink his own turbine pits, connected below by lateral tunnels to the main discharge tunnel. Some of the power at Niagara will undoubtedly be used in this way, and in the case of industries requiring a large amount of power it will be economical to purchase a site and water rights. Such a plan is, however, not adapted to smaller factories. Obviously for them it would be more economical to develop the power in one or more central stations by turbines of large size under common management. Further, once given the means of distributing power instead of water, an important extension of the project becomes possible. Besides supplying power to industries which may locate themselves at Niagara, the power may be transmitted to the existing factories in Buffalo and Tonawanda. Arrangements are already proceeding to transmit 3,000 h.p. to Buffalo, a distance of 18 miles, to work an electric lighting station.

In 1890, Mr. Adams, the president of the Niagara Construction Company, visited Europe to examine systems of power distribution. It was in consequence of this visit that the important modification of the plans of the company involved in the substitution, to a large extent, of a system of power distribution for a system of water distribution came to be adopted. The American engineers were anxious to obtain the best European advice as to the methods best suited to the local conditions. A commission was formed, consisting of Lord Kelvin, Dr. Coleman Sellers, Prof. Mascart, and Colonel Turrettini, and an invitation was given to engineers and engineering firms in Europe and America to send in competitive projects for the utilisation of the power at Niagara and its distribution to different consumers at Niagara and in Buffalo by electrical or other means. Many of the plans sent in were worked out with great care and completeness. As to the hydraulic part of the projects there was some approach to general consent as to the arrangements to be adopted, but as to the methods of distributing the power there was an extraordinary diversity. Generally the commission reported in favour of electrical distribution, with perhaps a partial use of compressed air as an auxiliary method. Generally also they reported in favour of methods of distribution by continuous currents in preference to alternating currents. Since the date at which the commission reported, the Frankfort-Lauffen experiment has been made, and in the opinion of some electrical engineers a distinct advance has been achieved in the use of alternating currents at high potential. The company has not yet decided to adopt any plan for the central stations except in a tentative way. One or more turbines of 5,000 h.p. are to be erected, and probably at first this power will be distributed to Buffalo by an alternating current system. The cost of a steam horse-power at

Buffalo is reckoned at 35dol. per annum. I believe the company will be able to deliver power at from 10dol for large amounts and a greater price for small amounts, this price being reckoned for 24 hour days. The new industry of electric lighting has made necessary the provision of large amounts of motive power. Electric traction similarly depends on the supply of motive power. New chemical and metallurgical processes are being introduced which entirely depend for their commercial success on the supply of motive power at a low price. Niagara is likely to become not only a seat of large manufacturing operations of familiar types, but also the home of important new industries.

TAUNTON.

The following is the report of the Electric Lighting Committee on the purchase of the Taunton electric light works:

Your committee report that they have instructed the town clerk and borough surveyor to obtain the necessary information required to be given in, and in connection with, the memorial advertisement and draft license, which has been done. They present herewith the memorial, which will require the seal of the Council, and the drafts advertisement and license. It is necessary that a cheque for £50 should be paid to the assistant secretary of the Board of Trade, and they present cheque for signature. The town clerk has made arrangements with Messrs. Sharpe, Parker, Pritchard, and Barham, of 9, Bridge-street, Westminster, to act as his agents, and upon agency terms in obtaining the license, and he has informed the committee that he hopes he will be able to obtain the same at a less sum than was originally contemplated. Your committee have adopted the recommendation of the Lighting Committee as to the distribution of the seven additional lamps for street lighting. Your committee present herewith the report of the borough surveyor as to the alleged vibration from the electric lighting works, and as to the measures which have been taken to remedy the smoke nuisance, as to which complaints have been made. Your committee recommend that the amount necessary for the purchase of the electric lighting works, plant, machinery, and undertaking for the obtaining of the license and the costs attendant thereon, and for the improvement and extension of the works, machinery, and wires, be raised by borrowing the same under the powers and provisions of the Taunton Corporation Act, 1889, and that the same be repaid during a period of 30 years, or such other period as the Local Government Board will grant for such purpose. The following is the borough surveyor's estimate for improving and extending the works, plant, and distributing mains:

Purchase of works	£9,300
Substitution of underground for overhead wires by the Fowler Waring system	1,290
Extra wires in Corporation-street and Hammet-street	80
Taking up and laying pavement in present area	155
Extension of lighting (including taking up and laying pavement)	432
Wiring from mains to houses and transformers	300
Alteration of arc lamps	50
Extra wires for crossing roads	15
Alterations at depot	506
Legal expenses	350
Working capital	1,000
Meters	300
Sundries	222
Total	£14,000

The borough surveyor reported as follows:

I have very carefully investigated the complaints made regarding the electric light works in St. James's-street and Middle-street. I have visited the works many times and the above-named streets at all hours up to midnight, and have tried several experiments without finding a trace of vibration in either street; upon one occasion I was permitted to have the windows opened and closed at Mr Ravenhill's, i.e., Mr Showers's house, which is directly opposite the gates of the works—and it required a strain to catch the least sound of the works with all the upper windows open (I standing in the hall), and when the windows were afterwards closed not a sound could be heard, or the least vibration felt; both Mr. and Mrs Ravenhill were present with me, and neither of them could detect a sound from the works, and they also stated that they have not had to complain of any nuisance from the works the three months they have occupied the house, nor have they felt any vibration whatever. I have had the doors of the works open and shut, and have tried with a tuning fork against the glass of my watch, but have failed to detect vibration or the faintest tremor. The house adjoining the works belonging to Mr. Durham is the one exception; there a grinding noise can be heard in the rooms nearest the wall of the works, and also at the cottage in St. James's-street there is a little sound, but Mr. Yea and his wife both assured me that there was nothing to complain of, and that they had lived there some time. Therefore the question of vibration I consider has been somewhat exaggerated, but if the engines and dynamos were bedded properly on felt or rubber the sound would be considerably less; some of the timbers are also shrunk with the heat, and these assist in making a noise, but taking the works as a whole I consider the engines and machinery are running smoothly, and that there is little to complain of, especially when the doors of the works are closed. Regarding the complaint about smoke and the deposit of soot, certain alterations have been made which appears to have had the desired effect upon the latter, and the using of better coal has prevented the smoke nuisance. A steam jet has been carried up outside and through the chimney shaft about 30ft. from the base, and is connected with the boiler, so that a pressure of steam is brought to bear upon the dust when the tubes are being blown out, and which causes it to deposit at the bottom of the shaft, and here an iron door has been placed, so that the deposit can be at once removed instead of as formerly, when it would lie there until blown up the chimney by the great draught when the dampers were being manipulated. I have frequently watched the stack since the new coal has been in use, and I have seen a little brown smoke (for less than two minutes) when the lights were being put on in the town, and at other times nothing which could be called a nuisance could be seen issuing from the stack. The exhaust which is connected with the water heater should be carried in another direction; this would prevent the steam being blown into Middle-street; this is caused by the heat not doing its work properly. I have pointed this out to the manager, who has promised to get it rectified. Therefore the summary of my report is that I have not been able to detect vibration in the streets or premises near the works, neither is there a nuisance from smoke, and if the small matters suggested are attended to and the works carefully conducted, there should not be any reasonable cause of complaint.

At the last meeting of the Council, the MAYOR, in moving the adoption of the report, observed that he thought the sum of £14,000 for the purchase of the works, the providing of a working capital, etc., was an exceedingly satisfactory one. They would remember that the estimate suggested by Mr. Kapp for a similar installation with [illegible] tension came to £17,000, but now, for £14,000, by pursuing the course they had initiated, they got an installation in full working order, with all its improvements, with [illegible] dynamos, against three suggested by Mr. Kapp, and they also obtained all the plant and works.

During the discussion the following letter was read from Mr Kapp, dated July 13, accompanying a supplementary report on the lighting of Taunton by electricity:

The difference of £702 between the figures given in my unofficial letter of May 6, and the figures given in the present supplementary report, is due to the fact that, as I informed you at the time, the estimate on which my unofficial letter was based was merely an approximate estimate, and that I had not taken [illegible] on the price of the superfluous plant into account. I give this explanation now to avoid further delay in correspondence.

The following is the supplementary report alluded to:

31, Parliament-street, Westminster.

Gentlemen,—Supplementary Report on the Lighting of Taunton by Electricity.—In my report on the above subject, dated April 26, 1892, I advised you not to buy up the whole of the existing electric light undertaking in any such manner as would compel you to carry on the present system of working, but to buy only such portions of it as can be utilised when the present system of working has been changed to what is known as the three-wire system of direct supply, with auxiliary storage batteries. If, nevertheless, you determine to buy up the whole undertaking as a going concern, you can do this on the following basis: 1. You pay for those parts of the plant which I advised you to buy for the sum stated in my original report, viz., £5,250. 2. You pay for the remainder of the plant which will have to be discarded when you adopt the improved system of supply, and which hereafter I call the superfluous plant, such a sum as you are likely to realise by selling the then superfluous plant in the open market, less the amount you will lose in working the present undertaking, and less the interest on the selling price of the superfluous plant. In order to arrive at the total purchase price it is therefore necessary to make a valuation of the price which the different parts of the superfluous plant will fetch if sold in the open market, and to estimate what length of time will be required to change over from the present uneconomical system of supply to the economical system I advised you to adopt. As regards the time required for the reconstruction of the work, I consider that one year will be sufficient for this purpose, and if you commence the reconstruction immediately after completing the purchase the loss suffered during one year's working of the present plant will have to be taken into account. This loss I estimate at £350. The prices which the superfluous plant may, at the end of a year from now, be expected to realise if sold in the open market, are as follows: Countershaft and belts, £220; four arc machines, [illegible]; two alternators and accessories, £900; 70 arc lamps, [illegible]; [illegible] posts, £308; 830 insulators, £41; Elwell Parker dynamo, [illegible] dynamo, batteries, motor, switchboards, incandescent lamps and accessories, £425; total, £3,400; deduct loss on one year's working, £350, and 3½ per cent. on £3,400, £102, would make a total of £2,948; add price of useful plant as per my original report, [illegible], leaving total purchase price at £8,198.

GISBERT KAPP, M.I.C.E.

Ultimately the report of the committee was adopted by 11 votes in favour and three against.

NEW COMPANIES REGISTERED.

American Insulated Wire Company, Limited -Registered by T. T Hull, 22, Chancery lane, W C , with a capital of £75,000 in £5 shares. Object to acquire certain letters patent, patent rights, and inventions relating to improvements in the manufacture of wire, wire ropes, and cables for electric purposes and to develop and turn the same to account: as dealers in wire, wire ropes, and cables of all kinds, and as mechanical and electrical engineers, electricians, founders, machine makers, suppliers of electricity, and manufacturers of electrical apparatus. The first subscribers are:

	Shares
C. G. T. Neuman, Forster-square, Bradford	1
J. B. Atherton, Rainhill	1
W. Brigg, Hawkstone, Keighley	1
H. Neumann, 13, Claremont, Bradford	1
J. Atherton, Huyton	1
H. M. Brigg, Hawkstone, Keighley	1
F. J. Leslie, 15, Union court, Liverpool	1

There shall not be less than three not more than seven Directors; the first are to be elected by the signatories to the memorandum of association. Qualification not specified Remuneration to be determined by the Company in general meeting.

PROVISIONAL PATENTS, 1892.

JULY 25.

7404A. **Improvements in or relating to dynamo-electric machines and electric motors.** Sidney Howe Short, 18, Buckingham street, Strand, London (Date claimed under Patents Rule 19, April 19, 1892.)

13507. **Conduits with insulators for underground conductors for the distribution of electricity.** William Harding Scott, Gothic Works, King street, Norwich.

13541. **Improvements in the manufacture of continuous lengths of tube by electrolysis** Francis Edward Elmore, 28, Southampton buildings, Chancery lane, London

13542. **An improvement in tanks or cells for electrolysis and like purposes.** Francis Edward Elmore and Alexander Stanley Elmore, 28, Southampton buildings, Chancery-lane, London.

13543. **Improvements in electrical installations for producing alternating currents.** Siemens Bros. and Co., Limited, 28, Southampton buildings, Chancery lane, London. (Siemens and Halske, Germany)

13549. **Improvements in dynamo electric machines.** Frederik Vilhelm Andersen, 40, Chancery lane, London (Complete specification.)

13557. **Improved system of electric traction for railway trains, tramways, and the like, and apparatus in connection therewith** William Phillips Thompson, 6, Lord street, Liverpool. (La Societe Anonyme pour le travail electrique des metaux, France)

13559. **An improved telephonic plant for private and domestic use** Jules Carpaux, 323, High Holborn, London. (Complete specification.)

JULY 26.

13592. **Improvements in and relating to electrical accumulators for secondary batteries.** David Young, 11 Southampton buildings, Chancery lane, London (Arthur Eastman Colgate, United States.) Complete specification)

13595. **Improvements in apparatus for varying the strength and direction of electric currents.** James Alfred Ewing and Charles George Lamb, Langdale Lodge, Cambridge

13619. **Improvements relating to electrical fire alarms and the like.** William Henry Munns, 106, Victoria chambers, Chancery lane, London. (Archibald H. Brintnell, Canada)

13639. **Improvements in acoustic telephones.** Alfred Lussack Simpson, 53, Chancery lane, London. (Complete specification.)

13648. **Improvements in electric railways.** Mark Wesley Dewey, 45, Southampton buildings, Chancery lane, London. (Complete specification)

JULY 27.

13678. **An electric combination contact bell push and pull.** William Robert Webb, 12, Shaftesbury road, Hornsey rise, London.

13683. **Improvements in the method of and apparatus for starting electric motors.** Thomas Reginald Andrews and Thomas Preece, 20, Charles street, Bradford.

13685. **Improvements relating to the saturation or impregnation of organic fibrous and cellular matter with liquids by the aid of electricity and to apparatus therefor.** Henry Harris Lake, 45, Southampton buildings, Chancery lane, London. (Gustav Adolph Oncken, United States)

13694. **Improvements in alternate-current transformers.** Walter Claude Johnson and Thomas Boydon, 28, Southampton buildings, Chancery lane, London

13698. **Improvements in the treatment of mandrels for electrolytic deposit of metallic tubes** Francis Edward Elmore and Alexander Stanley Elmore, 28, Southampton buildings, Chancery lane, London.

13702. **Organisation and arrangement of a telephonic news transmitter.** Theodor Puskas, 19, Southampton buildings, Chancery lane, London

13718. **Improvements in conduits for electric mains and in laying the same** Henry Lewis Doulton and Charles Edward Morris, 24, Southampton buildings, Chancery-lane, London.

JULY 28.

13763. **Improvements in incandescent electric lamps.** John Bridges Lee, 3, Brick court, Temple, London.

13764. **Improvements in the construction of secondary batteries.** John Bridges Lee, 3, Brick court, Temple, London

13785. **Improvements in alternate-current electro-dynamic machines** Maurice Hutin and Maurice Leblanc, 28 Southampton buildings, Chancery-lane, London.

JULY 29.

13850. **Improvements in incandescent electric lamps and in apparatus connected therewith** Sir Charles Stewart Forbes, Bart., 21, Finsbury pavement, London.

13854. **Improvements relating to the application of electricity in connection with chairs, known as "dental chairs," for carrying out dental and other surgical operations** Charles Frederick Rowley, 20, High Holborn, London

JULY 30.

13856. **Improvements in electric bells** Gustav Binswanger and Herbert John Coates, 71, Queen Victoria street, London

13879. **Improvements in telephone receivers** Ernest Walter Lawson Harrison and Sydney Murray, 53, Arcade chambers, St. Mary's Gate, Manchester

13894. **Improvements in submarine telegraph cables.** William Henry Preece 28, Southampton buildings, Chancery lane, London

13919. **Improvement in incandescent electric lamps** Elihu Thomson, 45, Southampton buildings, Chancery lane, London. (Complete specification.)

13920. **Improvements in methods of regulating electrically-driven mechanism and apparatus for putting the same into operation.** Walter H Knight and W. [illegible] Potter, 45, Southampton buildings, Chancery lane, London (Complete specification)

SPECIFICATIONS PUBLISHED.

1891.

5790. **Incandescent electric lamps** Boehm and Bailey

11447. **Electric arc lamps.** Norman and Payne.

11891. **Telephone switch devices.** Thompson. (Dietz.)

13384. **Electrical contacts.** Forbes.

14040. **Electric lighting, etc., apparatus for gas burners** Lake (Orling

14854 **Insulating electrical conducting wires, etc** [illegible]

14916 **Magnetic separators.** Arnall.

15050 **Electrolysis.** Le Sueur

15214 **Telephone receiver** Harper.

15243 **Electrical chronographic apparatus.** Wells

15872. **Electric motors etc** American Elevator Company (Otis Bros and Co)

18272. **Electric belts** Chadwick

1892

3654. **Electric burglar alarms** Richter.

7509 **Alternating current electromagnetic motors** [illegible] (Stanley and another)

9343 **Electric connectors** Burton

9356 **Distributing electric currents** Burton

9362 **Electric metal working apparatus** Burton

9365 **Electric motors, etc** Lundell and Johnson

9891 **Electric meters** McKenna and Wood

10715. **Electrical conductors** Jackson

10850 **Primary voltaic batteries** Weymersch.

10870 **Electrical measuring instruments** Lake (Weston

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	[illegible]
Brush Co.	—	3
— Pref.	—	[illegible]
India Rubber, Gutta Percha & Telegraph Co	10	[illegible]
House-to-House	5	4
Metropolitan Electric Supply	—	[illegible]
London Electric Supply	5	[illegible]
Swan United	3¾	[illegible]
St. James'	—	[illegible]
National Telephone	5	[illegible]
Electric Construction	10	[illegible]
Westminster Electric	—	[illegible]
Liverpool Electric Supply	[illegible]	[illegible]
	3	[illegible]

NOTES.

Salford.—Tenders may be invited shortly for Salford central installation.

Personal.—Mr. H. D. Cheever, of the Okonite Company, is in England on business.

West Hartlepool.—The tenders for Hartlepool co-operative stores must be in by to-night (Friday).

Wigan.—The Wigan Town Council have resolved to ask for extension of their provisional order for two years.

Burnley.—Tenders will soon be required for machinery at Burnley; the tenders for the buildings are required by the 30th inst.

Book Received.—"Chemical Theory for Beginners," by Leonard Dobbin, Ph.D., and James Walker, Ph.D., D.Sc. Published by Macmillan and Co.; price 2s. 6d.

Belt Slipping.—To prevent slipping, an American company now produces belts faced with corrugated rubber on the inside, which runs over a pulley of the same nature.

Electric Traction.—A scheme, it is stated, is being brought forward in America for the establishment of an electric power and traction system involving the erection of engines for a total of 100,000 h.p.

East Sussex.—A committee has been appointed to go into the question of electric light for the East Sussex County Hall. The committee consists of Mr. Curry, Major Edwardes, and Mr. Farncombe.

American Stock.—Anyone interested in stocks and shares would be pleased to receive a copy of the circular of Whittaker and Hodgman, of St. Louis, showing a classified list of securities with information.

Fireman's Exhibition.—A fireman's exhibition was opened on Tuesday at the Royal Aquarium, Westminster, and will remain open until the end of the month. Some interesting alarm arrangements are shown.

Bournemouth.—The General Purposes Committee of the Bournemouth Town Council have referred to the Lighting Committee the report of Prof. Kennedy as to the lighting of the pier and pleasure grounds by electricity.

Electric Crane. — Tenders are required by the Manchester Gas Committee for an electric crane at their electric light station. The tenders are to be sent, in by August 19, to Mr. C. Nickson at the Manchester Town Hall.

Hat Brushers.—The Crocker-Wheeler motors are now used for hat polishing. The hat is mounted on a block on a spindle and, whizz! the polishing is done in an instant. The ironing can be done by electricity also, and what more could you want—except a new hat!

Chicago.—Sir H. Trueman Wood presents his report on the Chicago Exhibition in the *Journal* of the Society of Arts this week. They have not yet all the power they want for the dynamos, and would like one or two 500-h.p. engines. Combined plants would also be acceptable.

Electrical Works.—If anyone knows of a good and convenient site (with or without shops) for establishment of heavy electrical engineering works in or near London, it would be interesting to hear of such, as the progress of the trade has caused one or two such enquiries to reach our office.

Durham College, Newcastle.—Complete courses in mechanical, marine, and electrical engineering are now organised in the Durham School of Science, Newcastle-on-Tyne, and in order that real practical experience can be obtained, arrangements are made for pupils to work part of the time during vacation in some of the large engineering works in the neighbourhood.

Pontypool.—Application has been made to the Board of Trade by the Pontypool Electric Light and Power Company, Club-chambers, Pontypool, for a license to supply electricity within the district of the Local Board. Messrs. Sherwood and Co., 7, Great George-street, are the London agents.

Wigan Tramways.—We hope that the reconstruction of the Wigan tramways, as at one time proposed, will embody the introduction of electric traction. It is a good chance, and if possible financially, should be taken. Mr. Heaton has just been engaged as engineer for the reconstruction.

Heckmondwike.—Mr. F. W. Reuss, writing to the Dewsbury paper, suggests the use of the continual flow of water in Heckmondwike, power being taken at Dunford Bridge by cables along the land of the Water Works Board. Batley, he says, might also obtain power in the same way.

Waterford.—The Bray Township Commissioners have written to Waterford to say "the light is very satisfactory." The borough treasurer of Kilkenny writes urging Waterford to follow in the footsteps of St. Pancras, Dublin, and other places, keeping the contract for the lighting in their own hands.

Brooks Cables.—We are very pleased to learn that the Brooks oil system of cables is to be used at Chatham for the high-tension alternating underground mains for the Rochester, Chatham, and District Electric Lighting Company. The Brooks system has always given satisfaction and deserves further extension.

Dundee.—At the meeting of the Electric Lighting Committee of the Dundee Gas Commission held last week, the following names were selected for recommendation to the Board for the post of electrical engineer: Mr. W. H. Brownlee, Glasgow; Mr. Charles Yeaman, Liverpool; Mr. A. F. Proctor, Newcastle-on-Tyne; Mr. A. B. Gill, London.

Grimsby.—At the Grimsby Town Council meeting last week it was resolved to authorise the Lighting Committee to take into consideration the desirability of lighting the important thoroughfares, squares, and markets in the borough with the electric light, and to obtain statistics and the probable cost, and to report thereon. It was explained by Mr. Connell that no money would be spent; it was simply a matter of enquiry.

Electric Railway.—It is announced that the New York, New Haven, and Hartford Railroad is constructing a four-track line, of which the two inside tracks are to be equipped for electricity, instead of steam, for both passenger and quick goods traffic. The line is 74 miles long, and the distance is to be covered in 60 minutes. An overhead wire system is to be used. The central track will be fenced in, and no level crossings will be allowed.

Chesterfield.—At the quarterly meeting of the Chesterfield Town Council on Tuesday the Mayor moved the appointment of a committee to consider the cost and advisability of lighting the town with electricity. He said the gas they used was not only high priced, but bad in quality. He thought the Corporation should obtain a provisional order, and carry out the lighting to prevent another monopoly. The motion was carried.

Alternating Currents.—By the courtesy of the editor of the N.Y. *Electrical Review* we have received advanced proofs of an article entitled "Note on Some Experiments with Alternating Currents," read at the American Institute of Electrical Engineers at Chicago by Dr. Louis Duncan.

assisted by Mr. E. R. Carichoff and Messrs. R. H. and G. E. Hutton. Although very interesting, it is impossible, by reason of pressure on our space, to give it this week.

Glasgow.—The Sub-Committee on Contracts of the Gas and Electric Lighting Committee of Glasgow Town Council recommended the Town Council, at their meeting on Thursday, to accept the offer of Messrs. Easton and Anderson, for the engines for the new electric lighting station, at a price of £1,108; and the offers of the Brush Electric Lighting Plant Company for the dynamos and the arc lamps, the contract price for the former being £1,510, and for the latter, £7. 13s. 8d. per lamp.

Barking Cars.—On the eve of renewal of the contract for the Barking road cars the North Metropolitan suddenly threw up the contract, and this just after putting the line into repair, a matter the traction company have been urging for months as causing breakdowns; and in proof, no stoppages have occurred during the last fortnight since the repairs. The affair affects both the traction company and the Electrical Power Storage Company, and will, we fear, form the subject of a lawsuit.

Cardiff.—A lengthy report, which had previously been presented to the Cardiff Lighting and Electric Committee by the sub-committee and accepted, was submitted to the Council on Tuesday as incorporated in the minutes of the meetings of the committee. The report stated in detail the result of the investigations of the sub-committee into the question of the electric lighting of the borough, the approximate cost of which to commence was estimated at between £25,000 and £30,000. The minutes were passed.

South African Journal.—We have received the first number of the *British and South African Export Journal* (53, Carter-lane, Doctor's-commons). It is a bright, well-written, practical journal, and now that Africa is growing in importance, and more particularly at this moment when Kimberley Exhibition is about to be opened, this journal should receive a warm welcome from British manufacturers. The price is sixpence, and it is illustrated, the first number containing a photogravure of the celebrated Royal Mail Cape steamer "Scot."

Liege.—The determination has been taken by the College Echevinal of Liége to establish a central electric station, and M. Mahiels, engineer-in-chief to the town, has been instructed to draw up a scheme. The project is expected to be drawn up by October, and the tenders may be accepted, if nothing interferes, before the end of the year. It is thought that a concession will be given with power of repurchase on reduced tariff year by year. The scheme is being the more forced forward as several private persons are thinking of putting up small stations for the supply of separate blocks of buildings.

City of London Lighting.—The annual meeting of the City of London Electric Light Company will be held early next month, and we believe the chairman's speech will contain some extremely interesting and inspiriting reading. Electrical engineers will await this event with much interest, although no doubt the account of solid results financially will be better next year. The company has been doing very good work lately, and credit is due to the directors, the contractors, and to the energetic manager, Mr. David Cook, who have all had an immense amount of hard work to do during the past year.

Bilston Market Hall.—This new market hall, which was formally opened on the 9th inst. by Sir Alfred Hickman, M.P., is noteworthy in being entirely dependent upon electricity for lighting. The interior is lighted by three 2,000-c.p. arc lights and by 74 incandescent lamps of 16 c.p. in the closed stalls, offices, etc., and the exterior by two 2,000-c.p. arc lamps. The whole of the plant, including loco. boiler, engine, and dynamo, has been supplied and erected by the Brush Electrical Engineering Company, Limited, through their Manchester branch, to the requirements of the township surveyor, Mr. C. L. N. Wilson.

Cheltenham.—The arrangement of the electric lighting does not seem to be going on very fast at Cheltenham. At the last Town Council meeting the Electric Lighting Committee reported that they had requested the town clerk to write to the Board of Trade, forwarding copies of the borough surveyor's and Prof. Ayrton's reports on electric lighting in the borough, explaining the present position of the matter, and giving the reason why greater progress in it had not been made. The question of another interview with Prof. Ayrton was adjourned for further consideration. These minutes were adopted without discussion.

Croydon.—As we mentioned last week, the Croydon Corporation have decided to keep the option of ownership of the electric lighting. They now invite offers for transfer of the powers with option of repurchase. Tenders must state the terms and the system proposed. Tenders must be sent in to Mr. C. M. Elborough, town clerk, Town Hall, Croydon, by the 15th of September. The town is a large one—much larger than many of the other towns now going in for the light—and is worth careful attention from our representative engineers. Finance, we suppose, will have to step in and have its way before the station becomes an accomplished fact.

Blackpool.—The Blackpool Corporation have decided to adopt the high-tension alternating-current system of electric lighting, and active preparations are being made for an early commencement of the works. The appointment of Mr. John Hesketh, formerly with the Newcastle Electric Supply Company, as resident electrical engineer, has been confirmed by the Council, and the committee authorised to make application to the Local Government Board for sanction to borrow £26,000 for electric lighting purposes. The contract for the necessary machinery has been let provisionally to Messrs. Hammond and Co., of London.

Nelson.—The arrangements for electric light at Nelson (Lancs.) have come to a practical point. Tenders have been received and reduced by consideration of the Gas Committee to one—that of Mr. Barton being recommended for acceptance. The Local Government Board have sent in their approval of the Corporation's request for power to borrow £3,920. The committee have been given full authority to deal with the tenders and put the work in hand immediately. It is a small and useful installation, and care should be taken by the engineer in charge of it that it turn out thoroughly efficient, as its success may lead to a number of other small stations in the populous districts of the North.

Owens College.—A special course has been arranged at Owens College, Manchester, on the technical applications of electricity. A dynamo-house has recently been built in connection with the physical laboratory, containing a 7-h.p. Otto gas engine, two direct and two alternate current dynamo machines, specially constructed for purposes of instruction. In the laboratory full instruction is given in electric and magnetic measurements, testing of dynamos. If a student goes practically through this course he ought to be able to calibrate instruments and test dynamos or aid in this work, and if he can do this he can usually find a place of some kind in an electrical works at once. If he could further make a decent working drawing (how many

students can ?) he would really be worth paying on entering the shop, which is more than can be said for many technical students for a year or two after leaving the electrical "lab."

Blackburn.—At the quarterly meeting of the Blackburn Town Council last week it was resolved, on the motion of Councillor Thompson, that application be made to the Local Government Board, in pursuance of the provisions of the Electric Lighting Acts, and of the Blackburn Electric Lighting Order, 1890, for the sanction to the borrowing by the Corporation of the sum of £50,000 for the purpose of laying down an electric lighting installation in the borough, and for all necessary works in connection therewith. The Council also ordered that Mr. Barton, of Blackburn, in conjunction with the borough engineer, be instructed to prepare estimates, plans, and specifications of proposed electric lighting plant and works. Also that it be referred to the Gas Sub-Committee to select a suitable site for the electric lighting works, and to ascertain upon what terms Mr. Barton would act as engineer to the Corporation in fixing the electric lighting plant.

St. Pancras.—Tenders are required by the Vestry of St. Pancras for the following: (1) Supplying about 50 cast-iron columns for arc lamps; (2) supplying, fixing, and setting to work about 50 arc lamps, to be worked 11 in series by existing high-tension machines, drawing cables through pipes, providing switches, and making all connections; (3) supplying high-tension cables; (4) supplying cast-iron pipes for cables; (5) erecting the cast-iron columns, laying cast-iron pipes, constructing manholes with cast-iron covers. Drawings, showing the positions of the arc lamps and the constructing of the manholes, covers, pipes, etc., can be seen at the offices of Prof. Henry Robinson, C.E., 13, Victoria-street, Westminster, where copies of the several specifications can be obtained on payment of 2s. each. Tenders to be sent to Mr. A. E. Pycraft, chief clerk, Electricity Department, Vestry Hall, Pancras-road, N.W., by 22nd inst.

Accrington.—The electric light question is not dropped at Accrington, as it looked a while ago. Councillor Riley at the meeting last week moved that the Legal and Parliamentary Committee submit a full report with respect to the establishment of a central station. The provisional order expires during this month, and it seemed that a private company intended to apply for powers to supply the electric light not only for Accrington, but for the whole of the surrounding district. The ratepayers, he said, might find that their £500 had been spent to no purpose, and at some future time they might be called upon to buy out another gigantic monopoly. If the Corporation intended to adopt the electric light they should do it at once, or make way for someone else. Councillor Hardacre said he was informed that a number of local gentlemen had the matter before them, and intended, if the Corporation did not move, to take the matter up. The Mayor mentioned that they had some idea of utilising 200 h.p. from the destructors. The motion was carried.

Whitehaven.— The chairman of the Whitehaven Trustee Board referred at the last meeting to the proposed adoption of the electric light, and said that a letter had been received asking for certain information which it would be necessary for the Local Government Board to have before they could sanction the borrowing of the money. That information would be sent at once, and everything possible was being done to push the scheme forward. Mr. Robinson enquired whether any estimate had been made as to the number of people who would use the electric light when it was obtained. The chairman replied that there was an estimate in Dr. Hopkinson's report, but this was merely a guess, founded upon similar places where the electric light had been put down. As soon as certain information had been received from Dr. Hopkinson in regard to the probable price the electric light would be supplied at, efforts would be made to ascertain how many tradesmen and others would adopt it. Mr. Bowman thought this should have been done before the resolution was passed. A good feeling, however, is evidently present in the town.

Bedford.—The Corporation of Bedford, having resolved not to proceed themselves with the introduction of electric lighting into the borough, have had a special meeting to consider an application from the Bedford Electric Light Company for a transfer to them of the Board of Trade's provisional order, with a view to their undertaking the task. After a lengthy discussion, it was resolved to ask the Board of Trade's sanction to the transfer. In the meantime Alderman Hurst has withdrawn his name from the Gas and Electric Light Committee. During the recent discussions several allusions have been made to handsome profits accruing to the shareholders in the gas company, and the members of the Council who are also connected with the latter company are accused of opposing the introduction of the electric light from personal motives. The transfer to the Bedford Company certainly seems the best way of dealing with the matter, and we hope the project will not again fall through. There is, in Waterloo-place, an Electric Association—more or less moribund, we are afraid. But it is exactly in such crises that Bedford and Waterford are passing through that an association such as this might reasonably be expected to throw its weight against the machinations of the gas interest.

Hastings.—At the meeting of the Hastings Town Council last Friday the Public Lighting Committee reported that they have had under consideration the matter of the desirability of extending the electric light on the sea front. They had been in communication with the Hastings and St. Leonards-on Sea Electric Light Company on the subject, and had ascertained that the company were prepared to enter into a contract with the Corporation for a period of three years, by means of 51 arc lamps placed 80 yards apart (instead of 100 yards, the distance between existing electric lamps), the whole of the lamps to be lighted from sunset to 12 midnight, and after that hour each alternate lamp to be extinguished, and the other lamps to be kept alight till sunrise, the company undertaking to maintain a steady light, free from extinctions, at £25 per lamp per annum, the contract to commence as soon as the company had made the necessary additions to their machinery and mains. The committee were informed this machinery would be of the latest and most improved type, and duplicated to prevent any failure in the supply. The committee had fully discussed this offer, and had received from the borough surveyor a report on the subject. They recommended that the offer should be accepted. But it was decided to withdraw the matter for further consideration.

Wolverhampton.—At the quarterly meeting of the Wolverhampton Town Council on Monday, the Mayor moved the adoption of the Lighting Committee's report relative to the supply of electricity within the borough and the appointment of a special committee to advertise for tenders for the construction of the necessary works. He pointed out that the Corporation were compelled to take up the question of supplying the electric light in order to prevent a company securing a monopoly. Unfortunately they had experienced the result of the monopoly enjoyed by the gas company, and it was the duty of the Town Council to prevent another company exercising similar powers in

regard to the electric light. A company had been formed to supply electric light in the town, and unless the Town Council had applied promptly for a provisional order the privilege would have been secured by some other body. The superiority of the electric light over gas was admitted, and as many corporations had installed the light in their boroughs, he hoped Wolverhampton would follow their example. Alderman W. H. Jones, in seconding the resolution, said it was intended to light only a small area at first, and that it was the opinion of experts that in a short time the electric light could be supplied at the same price as gas. After a brief discussion, the resolution was agreed to unanimously.

Kimberley Exhibition.—Those who don't intend to exhibit at Chicago should certainly consider Kimberley. The exhibition at Kimberley is to be opened on September 8 by Sir Henry Brougham Loch, K.C.M.G., governor of the Cape of Good Hope. It is as well to remember that Cape of Good Hope is in Britain—Greater Britain—and is one of the most important of the United British States. It is not so very far away—14 days—and it takes seven days, even now, very often, to go from New York to 'Frisco. Our far west is in the Cape, and the development given to the original Far West must and will be given to the Cape and its upper dependencies, now becoming more and more important. Kimberley will be the starting point for much opening up of new work. The best means, the best methods should be used, and these are now generally electrical. Messrs. Mather and Platt are now undertaking the exhibition installation. The machinery will consist of three arc-light machines of the "Manchester" type, each of 10 amperes at 900 volts, to supply 18 arc lamps in series. Brockie-Pell lamps will be used, 36 in number, in the grounds, on sectional standards The building will be lighted by 700 16 c.p. lamps, supplied by three low-tension "Manchester" dynamos, giving each 130 amperes at 100 volts. A 100-ampere search light will be supplied by Messrs. Crompton. An electric tramcar will be run by Messrs. Gibson Bros. between the exhibition gardens and the Central Hotel at a charge of 3d. Messrs. Woodhouse and Rawson intend to have an exhibit, and there will be a good assortment of mining machinery.

Barnsley.—The electric light is again relegated to the future in Barnsley, for the Town Council has not risen to the occasion, and the amendment to the resolution to go on received most support. The meeting was held on Tuesday evening, the Park and Lighting Committee recommending: (1) That the electric light be installed on a site in Beckett-square, at an estimated cost of £18,382, but that at present only £13,332 be expended; (2) that Mr. A. Bromley Holmes be appointed electrical engineer, and that he be instructed to prepare all plans and specifications, and estimates of the electrical plant; and that the borough surveyor be instructed to prepare the plans, specifications, and estimates of the requisite buildings, and that such plans and estimates be submitted to the committee as early as practicable; and (3) that application be made by the Council to the Local Government Board for their sanction to borrow the said sum of £18,382. The Mayor moved the adoption of the report, and Alderman Wray seconded, saying something should be done to break the neck of the gas monopoly. Gas, which would cost £13 or £14 a year to a tradesman in Wakefield and other towns, would cost £22 or £20 in Barnsley, which was in effect a rate at 2s. in the pound on a tradesman rated at £70 a year; and he suggested that the present rating of the town had been made higher than it ought to have been simply to choke or keep back this scheme. Alderman Marsden, as chairman of the Finance Committee, deprecated this statement, and asked if it were thought they would put upon the poor of the town a rate in order to support a private company against the electric light. Dr. Halton moved that the matter be adjourned 12 months, and this was carried, only the committee voting for the resolution.

Oldham.—A Local Government enquiry was held last Friday before Colonel John Hasted, R.E., at Oldham, with reference to powers for borrowing £40,000 for electric lighting. The town clerk explained that the Corporation had acquired a plot of land in 1887 and a provisional order in 1890. They retained Prof Kennedy in February this year as electrical engineer, and he had drawn up a scheme for simultaneous lighting at first of 2,500 8-c.p. lamps on the two-wire system of bare wire mains. His estimate was £21,000, and the Corporation asked for £40,000 in order to be able to extend. A canvass has been made, and, with the Municipal Buildings, nearly 2,000 lamps will be at once taken up. Prof. Kennedy explained the details and cost. He proposed four 60-h.p. direct-driven sets, and others of 100 h.p. The batteries to be used for electric lighting purposes in the daytime would, he thought, be sufficient for a long time to come. They would keep 200 lamps alight for eight hours. The scheme was so arranged that the two-wire system could be changed to three wire if the demand required it, without interference with the streets, and the same engines and dynamos could be used. The question of laying the mains was one of great importance, and he first advised the modified adoption of the plan he had adopted in London, and which had proved very successful—laying the wires in a concrete trench under the pavement. In one or two places—at several crossings—insulated wires would be enclosed in cast-iron tubes. The cost he estimated as follows: The plant, including everything stationary, £8,800; the mains, £5,600; the buildings, £6,000; the meters, £600. He thought those prices were full. By the advice of the inspector, the cost of site—£4,000—was included in the estimated total cost of £26,000. There was no opposition.

Brussels.—At the discussion upon the adoption of electric lighting at Brussels some explanation was given as to the alleged raising by 40 per cent. of price of charge of Messrs. Crompton's estimate by the committee. M. Janssen stated that the various tenderers had taken different figures as to depreciation, cost of carbons, etc., and these had been all brought to one scale. M. Bede gave a long discourse, dealing with the technical and financial points of the scheme. The city, he said, had offered an installation of 10,000 lamps, with power of extension to 20,000 lamps. Of eight projects presented choice lay between that of the India Rubber Company (closest to the desires of the town) and scheme No. 2 of Schückert and Co. (the lowest) The India Rubber Company's tender was for 3,762,000f., and Schuckert's (No 2) 2,803,000f. The difference, said M. Bede, was still greater on examination, as the first would barely suffice for the 10,000 lamps, while Schückert's would supply over 13,000. So while paying 25 per cent. less, the town would obtain 30 per cent. more light. Schuckert's scheme was therefore only 58 per cent. of the cost of the other. The one company, though honourably connected, had carried out no central scheme, while the other had. The 16-c.p. lamp in Schuckert's installation would cost 1·56 centimes per hour, as against 2·40 centimes with the other. Why had the committee given the preference to the India Rubber Company? For thre emotives: because Schuckert's propose to use accumulators on too large a scale; also the I.R. mains are considered the better, both for material and on account of

facility of changing, so that it would be possible to start at once with a less costly station. M. Bède criticised all these motives. Accumulators were necessary to supply the outlying quarters; indiarubber was good for indoors, as Mr. Preece said in 1887, but not so good for outdoor underground work (though this applies to pure, not vulcanised, indiarubber). The I.R. cable supplied for the Theatre de la Monnaie had already cost in four years 8,700f. for repair. Besides, drawn-out cables lost their value. Suppose it was only half, this would make 2,042,000f. added to 2,447,000f. to-day—*i.e.*, 4,487,000 against 2,803,000; in other words to avoid paying 356,000f. extra now, they would have to pay 1,684,000f. extra later on—to economise 10,000f. a year interest, etc., now, they would pay 144,000f. a year for ever. The question was not one of first cost alone, but of maintenance, and M. Bède ended by demanding that the decision should be adjourned till October. M. Janssen wondered that M. Bède did not propose the adoption of M.M. Schückert's scheme. The discussion was adjourned. At their last meeting, after a long discussion, the Municipal Council decided unanimously (excepting M. Bède) to grant the concession to the India Rubber Company.

Melbourne Boilers.—"One Who Knows" writes to the *Building and Engineering Journal*, of Melbourne, with reference to the boiler tender for the electric light station: "The recent decision of the City Council as regards boilers to be used in connection with the electric lighting of the city has attracted considerable attention, and has been the subject of strongly adverse comment. The facts of the case seem to be as follows: Tenders were called for the supply of four water-tube boilers, each of 250 h.p., and capable of evaporating 7,300 gallons of water per minute. The usual conditions of tender and deposit were present, and amongst these it was directed that tenderers must be in attendance at the time of opening tenders. On enquiry as to when tenders were to be opened, that information could not be obtained; but after some days' delay the assurance was given that written intimation would be forwarded, so that tenderers might be present as directed. It is sufficient to say that the promised intimation was not sent. This and other minor irregularities might have passed unnoticed, had not the final selection of boilers by the Council lent them significance. The boilers accepted by the Council are those known as the 'Babcock and Wilcox,' and from the results of numerous and reliable tests, which have been frequently published, it will be seen that whatever governed the Council in their selection, it was certainly not economy. From these tests it will be seen that the 'Mills patent boiler,' which I understand was offered in this instance, has the following claims over the Babcock and Wilcox boiler: 35½ per cent. in economy, 43 per cent. more duty, and 40 per cent. greater efficiency. The water evaporated per pound of fuel by the former is shown as 9·39lb., by the latter 6·9lb., and it certainly cannot be questioned which is the more economical steam generator of the two. While the Babcock and Wilcox boiler has frequently entailed fines on its users for creating a smoke nuisance, the Mills boiler secures an almost entire absence of this disagreeable adjunct. All the foregoing information, no doubt, accompanied the tenders sent in by the agents for the Mills Patent Boiler Company, and also the published reports of the highest boiler experts in England, showing the superiority of the Mills over the Babcock boiler. The action of the Council, therefore, in rejecting the superior and economical steam generator in favour of its proved inferior is a matter worthy of the consideration of the ratepayers who find the money and look to their representatives on the Council for its proper application." Their correspondent concludes: "This is by no means the first instance in which the result of public competition has been decidedly the unexpected, and unless tenderers are encouraged in the belief that the merits of the article offered will be considered in determining selection, we shall arrive at a point at which it will be considered waste of time and money to compete for municipal work."

Dublin.—Last Friday the official tests of the Dublin electric light installation were commenced, under the direct supervision of Mr. Robert Hammond, of Hammond and Co., who have carried out the contract; Mr. E. Manville, electrical engineer to the Corporation; and Mr. Spencer Harty, city surveyor. The following engineers were also present: Mr. Charles J. Hall, co-patentee of the Lowrie-Hall system in use in Dublin; Mr. J. W. Chisholm and Mr. H. Dickenson, of Messrs. Hammond and Co.; Mr. M. Ruddle, on behalf of the Corporation; and Mr. Porte and Mr. Haslam, of the Electrical Engineering Company of Ireland. The members of the Electric Lighting Committee of the Corporation visited the works during the evening, and evinced the greatest interest in the running of the plant. They were afterwards entertained by Mr. Hammond in the large offices. The *Irish Times* gives the following account of the ceremony: "The magnificent alternating-current dynamos worked splendidly, and it must have been particularly gratifying to Mr. Hammond and Mr. Hall to hear the numerous favourable opinions that were expressed of their work by the engineers present. Messrs. Hammond and Hall were hard at work during the afternoon, evening, and night, attired like ordinary workmen, controlling the entire machinery with marked ability and precision, while Mr. G. W. S. Hawes, the young Dublin secretary of Messrs. Hammond and Co., was assiduously engaged for several hours in explaining the working of the plant to a succession of privileged visitors. There are three compound vertical engines working dynamos to supply the arc lamps in the streets, and three compound horizontal engines for private lighting purposes, these having been manufactured by Messrs. Victor Coates and Co., of the Lagan Foundry, Belfast. The dynamos for the private lighting are alternators, while those supplying the streets are Brush arc light dynamos. The assistants attending them wear india-rubber gloves, which effectually protect them in their dangerous occupation. As early as four o'clock in the evening the lamps on the circuit embracing Sackville-street, Westmoreland-street, Dame-street, and Grafton-street were illuminated, but in the clear daylight its effect was scarcely apparent. At nightfall a fine opportunity for observing the power of the new illuminant was afforded to thousands of the citizens who thronged the streets, and evidently much admired the light. In order to make the test more effective the gas lamps throughout the circuits operated on were left unlighted, and between eight and nine o'clock considerable disappointment was felt at the circumstance that while some of the lamps were giving a brilliant light others in their immediate vicinity were either flickering, or, having shown some signs of life, had gone suddenly out. The public were, of course, unaware of the cause of this, which arose from the circumstance that the engineers in Fleet-street were testing the circuits separately, and it appears that while these circuits are controlled from the central works, each individual lamp is regulated from the box at its base. About nine o'clock a second engine supplying the arc lamps in the streets was set to work, and the effect in the thoroughfares was quickly apparent." The lighting seems to have been a success, save that one of the machines failed to stand the twelve hours' test, the armature having given way. A further test takes place this week.

STEAM AND GAS ENGINES AT THE ELECTRICAL EXHIBITION.

Although the Electrical Exhibition has been closed it is none the less necessary that we should place on record some descriptions, with illustrations, of the steam and gas engines there exhibited, to some of which we referred in the article in our impression of July 1st (p. 31).

We may commence with the very fine triple-expansion engine, of which we have already given a few particulars. The engraving we now publish (Fig 1) is a front view of this engine taken from a position which shows nearly all the motion parts with the exception of the governors. The high-pressure cylinder is 12in. in diameter. This receives steam at 160lb. pressure per square inch, and exhausts into the intermediate cylinder, which is 18¾in. in diameter, and in its turn exhausts into the low-pressure cylinder, which is 30in. in diameter. All the pistons have a stroke of 18in., and when running at its full speed of 140 revolutions per minute the engine indicates 350 h p. The cranks are placed equidistant, the intermediate and low-pressure cranks following the high-pressure in order, and therefore each 120deg after the high pressure and after the intermediate cranks respectively. The high-pressure main valve is operated by one eccentric, and the cut-off valve, on Paxman's system, is operated by a pair of eccentrics through the medium of a slotted link, the position of which is controlled by the governor. The latter is placed behind the high-pressure cylinder, and is not seen in the engraving. One of the expansion valve eccentrics has a longer stroke than the other, and thus, if it be controlling the movement of the valve, cuts off steam earlier than when the link is pulled over, so that the valve is moved by the other eccentric.

The engine is fitted with a flywheel 6ft. in diameter, and the ground space covered is only 10ft. 6in. by 6ft. 9in., this width including that of the platform, which is 2ft. 9in. above the floor. The height of the engine from the floor to the top of the cylinders is 11ft., and above this stand the steam supply valve operated by a hand-wheel and bevel, gear shown in the engraving, and the sight-feed steam lubricators.

The engine is very much of the marine type, with semi A frame and turned wrought-iron columns supporting the cylinders. Every part of the engine is lubricated from fixed oil-boxes, the engine being provided with very ample bearing surfaces of all forms, and in every respect it is designed for running at full power for long periods. It is expected to develop an indicated horse-power for about 16lb. of steam. Of the central station multipolar dynamo connected directly to the crankshaft, and made by Messrs. Johnson and Phillips, we need say nothing here, as we described this machine in our impression for the 15th April last.

We may now turn to one of the smallest engines exhibited at work in the recent exhibition—namely, the Case high speed engine—illustrated in our engravings by Figs. 2 and 3. In this engine the cylinder is within a semi-rotating block, so that it may be called an oscillating cylinder; instead, however, of oscillating upon small trunnions in the manner commonly adopted, the ends of the whole block, with the diameter of the length of the cylinder, form the trunnions. The bearing surfaces are, therefore, so large that wear must necessarily be extremely slow. In this application, moreover, the cylinder is steam balanced, so that the pressure upon these surfaces is exceedingly small. The upper end of the cylinder (see Fig. 2) is closed to the steam only by the circular seat in which the cylinder block oscillates. On the lower end of the cylinder, to which is attached a long guide tube for the piston-rod, the same steam balancing is effected by the use of steam within a chamber between the circular seat and the cylinder block. The steam-ports are arranged in the cylinder block and circular seats, and steam is admitted and exhausted by the oscillation of the cylinder. In Figs. 2 and 3 the engine is shown as controlled by a governor which moves a throttle valve, but the engine is made as shown in Fig. 4, with an automatic cut-off valve operated by an eccentric, the position of which is controlled by a flywheel governor. The cut-off valve is a slightly tapered plug, closing or opening the steam port

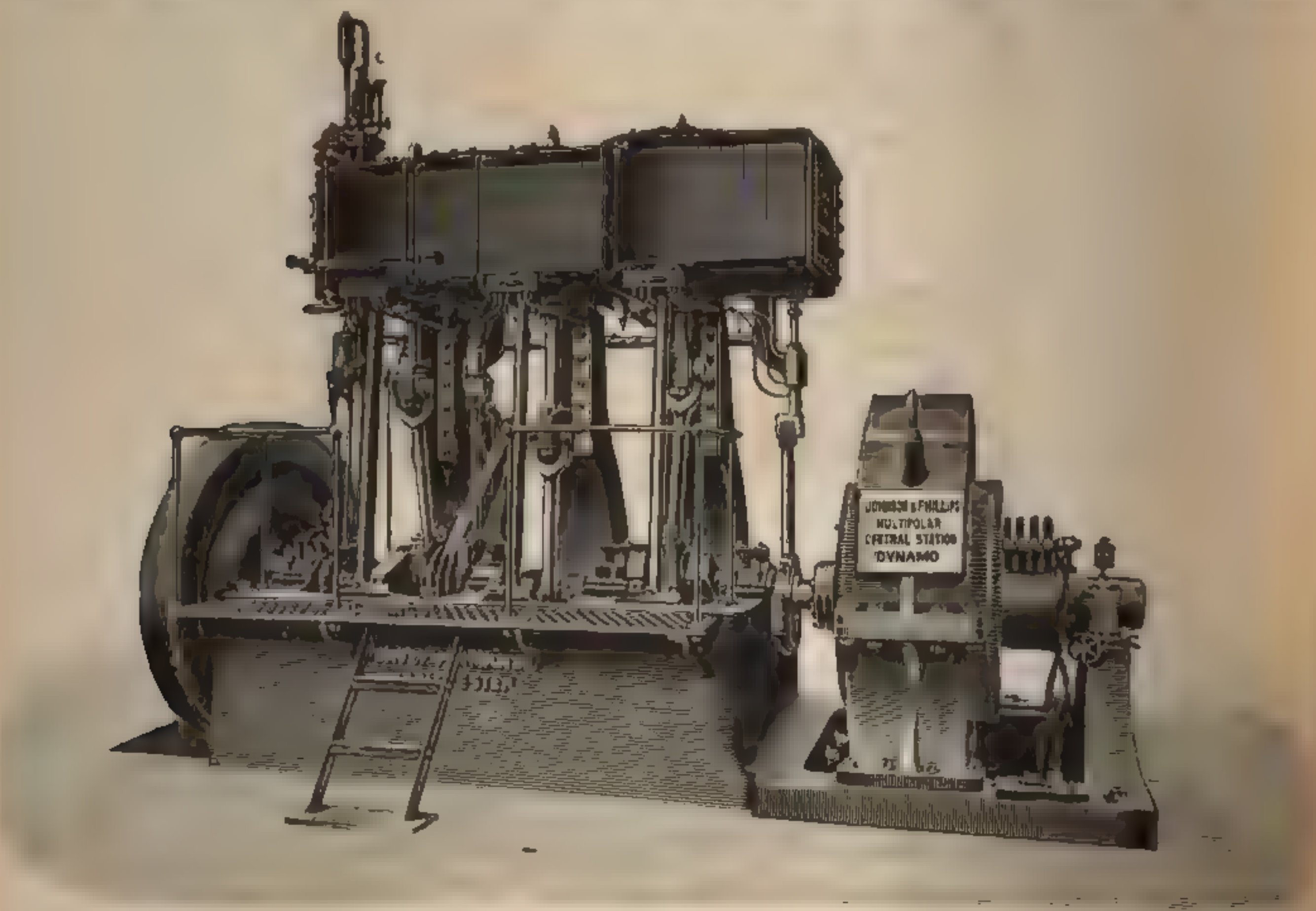


FIG. 1.

The exhaust remains unaffected by the cut-off. The diagrams, Figs. 5 and 6, are taken from one of

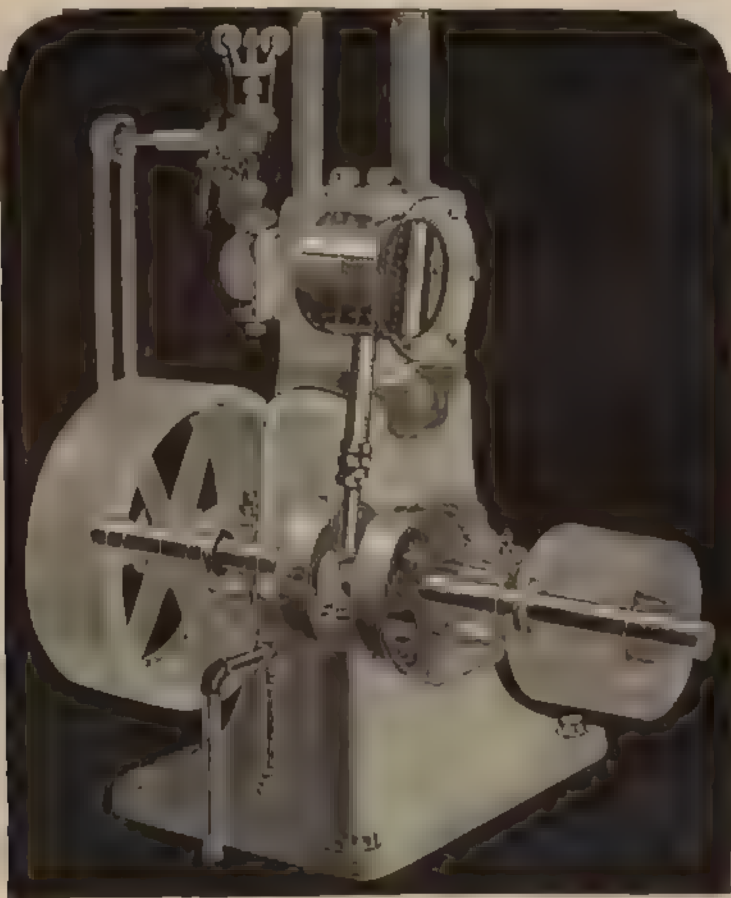


Fig. 2.

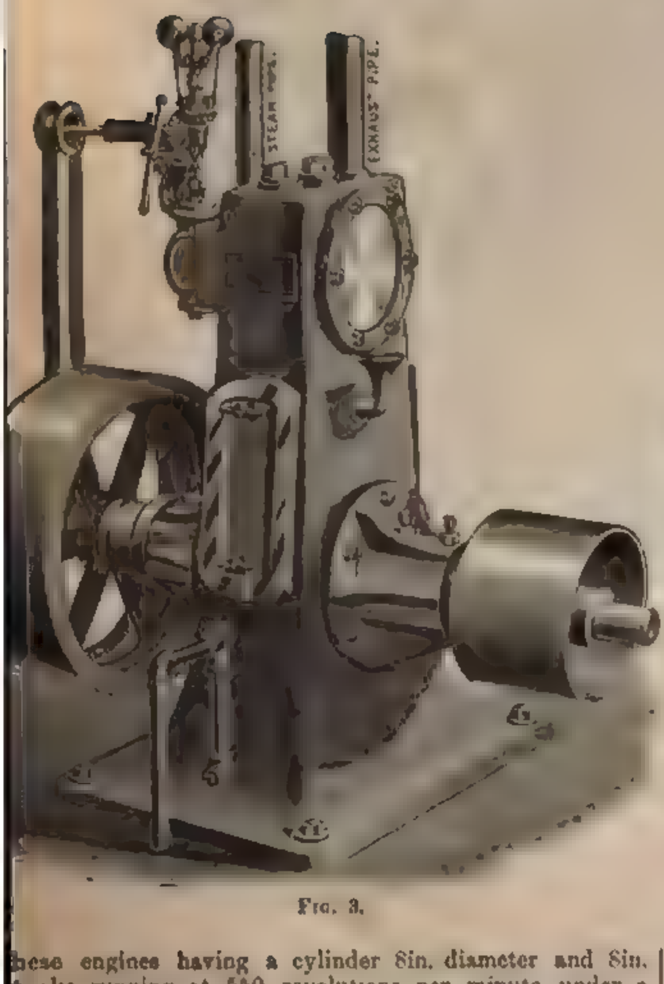


Fig. 3.

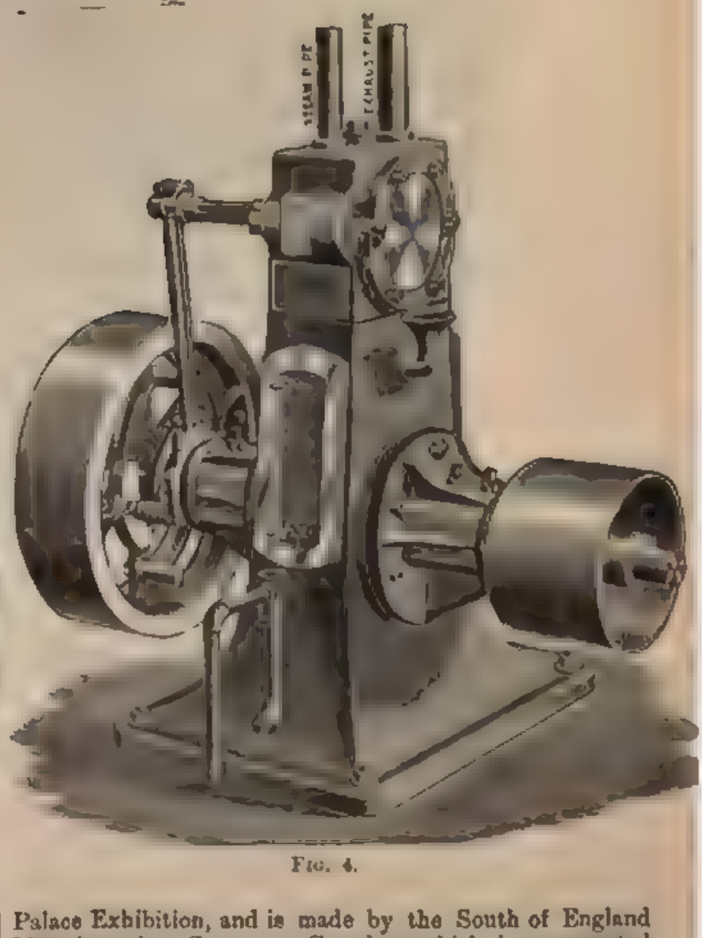


Fig. 4.

these engines having a cylinder 8in. diameter and 8in. stroke running at 550 revolutions per minute under a steam pressure of 120lb. per square inch. This little engine attracted a great deal of attention at the Crystal Palace Exhibition, and is made by the South of England Manufacturing Company, Croydon, which is represented

in London by Messrs. Charles Churchill and Co., of Cross-street, Finsbury. We may mention that the engine is made in several sizes and in several forms—namely, as a

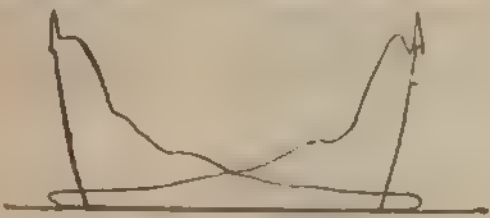


Fig. 5.

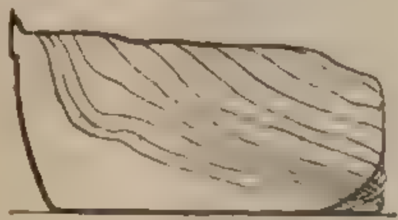


Fig. 6.

wall engine, as a launch or marine engine, as a hanger engine, and as a reversible pedestal engine.

ALTERNATE-CURRENT DYNAMOS.

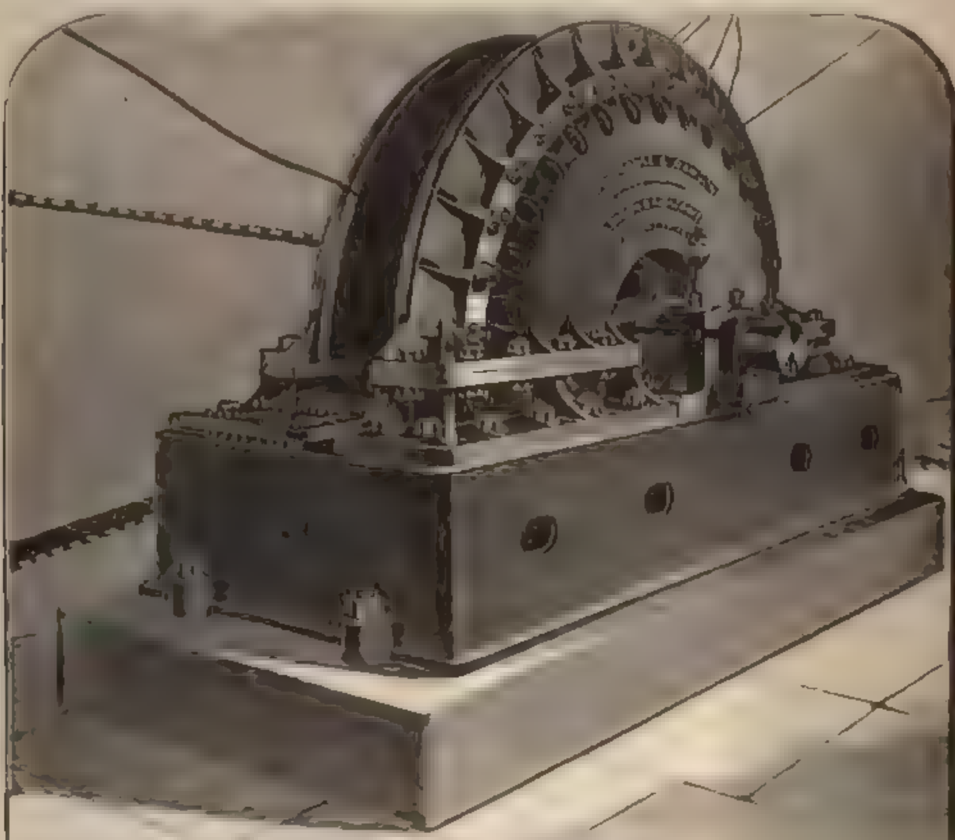
BY R. W. WEEKES, WHIT SCH.

Messrs. Woodhouse and Rawson.—The block of the Kingdon inductor made by this firm does not give much idea of the design and principles of action of this alternator. The machine belongs to the class of alternators

lately at the Crystal Palace. In fact, the design is still being altered, and for that reason the firm do not wish to publish many actual details.

The iron parts are all built up of charcoal-iron plates. The outer ring, which has a number of projections on the inside, forms the core for both the armature and exciting coils, the alternate projections being the armature cores. The exciting coils are placed round the others, and so connected as to give north and south poles alternatively. In the machine exhibited at the Crystal Palace the armature cores were considerably smaller than the magnet cores, and not equal, as shown in the sketches. In building up the segments, which are made of iron ·012in. thick, it is so arranged that the adjacent plates break joint. The revolving masses of iron which complete the magnetic circuit are also laminated, and are clamped in position by bolts passing through two steel discs, Fig. 8. The action of these revolving keepers can best be understood by means of separate sketches, Figs. 9, 10, and 11. In these only one armature core is considered, as the action on all of them is similar.

In Fig. 8 the keeper bridges cross the armature and the south pole of the field magnet, so that the lines of force pass as shown by arrows. Fig 9 shows the condition of the magnetic circuits when the keeper has passed on till it is exactly opposite the armature core. Then the actions of the north and south pole tend to produce equal and opposite magnetic flux in the armature core, and hence neutralise each other, so at that instant no lines of force pass through the armature core, but they will go as indicated. In the next, Fig. 10, the keeper unites the north pole to the armature, so that the flux is again a maximum, and in the opposite direction to that in Fig. 8. The keeper has now been moved through one thirty-second of a revolution, as there are 16 poles, and the E.M.F. induced will have passed through half a complete period. So in this machine the number of complete periods per second is equal



70-Kilowatt Kingdon Inductor.

in which the E.M.F. is produced by changes in the magnetic path. These changes cause a fluctuation of lines of force in certain definite places where the armature coils are situated. The diagrammatic sketch of the armature arrangements will help to show the method used, but unfortunately the sketch is not to scale, and the relative proportions are not the same as in the machine exhibited

to the product of the number of poles into the revolutions per second, and not half this quantity, as in the alternator described above. The action of the keeper in inducing the E.M.F. in the armature coils is not the only one that takes place, and it is doubtless the need of preventing the secondary effects that has induced the pending alterations in the design.

On comparing Figs. 9 and 10, with respect to the magnetic resistance of the iron circuits, it will be seen that in Fig. 10 the resistance offered to the magnetic flux is, roughly, double that in Fig. 9, but also the ampere-turns producing the flux are doubled, as two coils are acting, so that there should be about the same number of lines coming from each pole. But in a position about midway between these two there will be no such relation, and the resistance will have increased without a corresponding increase of magneto-motive force. This will cause a variation of the flux in the magnets and time to produce an alternating current in the exciting coils. This effect, and the large masses of iron exposed to changes of induction, and hence causing a large hysteresis loss, are the objections to this class of machine, but they may be reduced considerably by careful design. The advantages are all based on the fact that neither of the electric circuits are on the rotating parts. Thus no collector is required in either circuit. Also the insulation of the conductor is not so likely to break down, due to the mechanical vibration, as there will be little vibration in the fixed core. The present machine was connected up to give 110 volts when at the Palace, although it was never actually working. The connection-board at which the armature coils were connected would facilitate the rapid change from parallel to series, but the insulation appeared to be more fitted for low-tension working. The power required to excite the magnets is 6·8 per cent. of the total output, which is the highest figure in the adjoining list. The armature reaction will help to make this figure high, as the air spaces are short. The noise made by this alternator when running at full speed is objectionable, but doubtless the makers will remedy this when bringing out their new pattern.

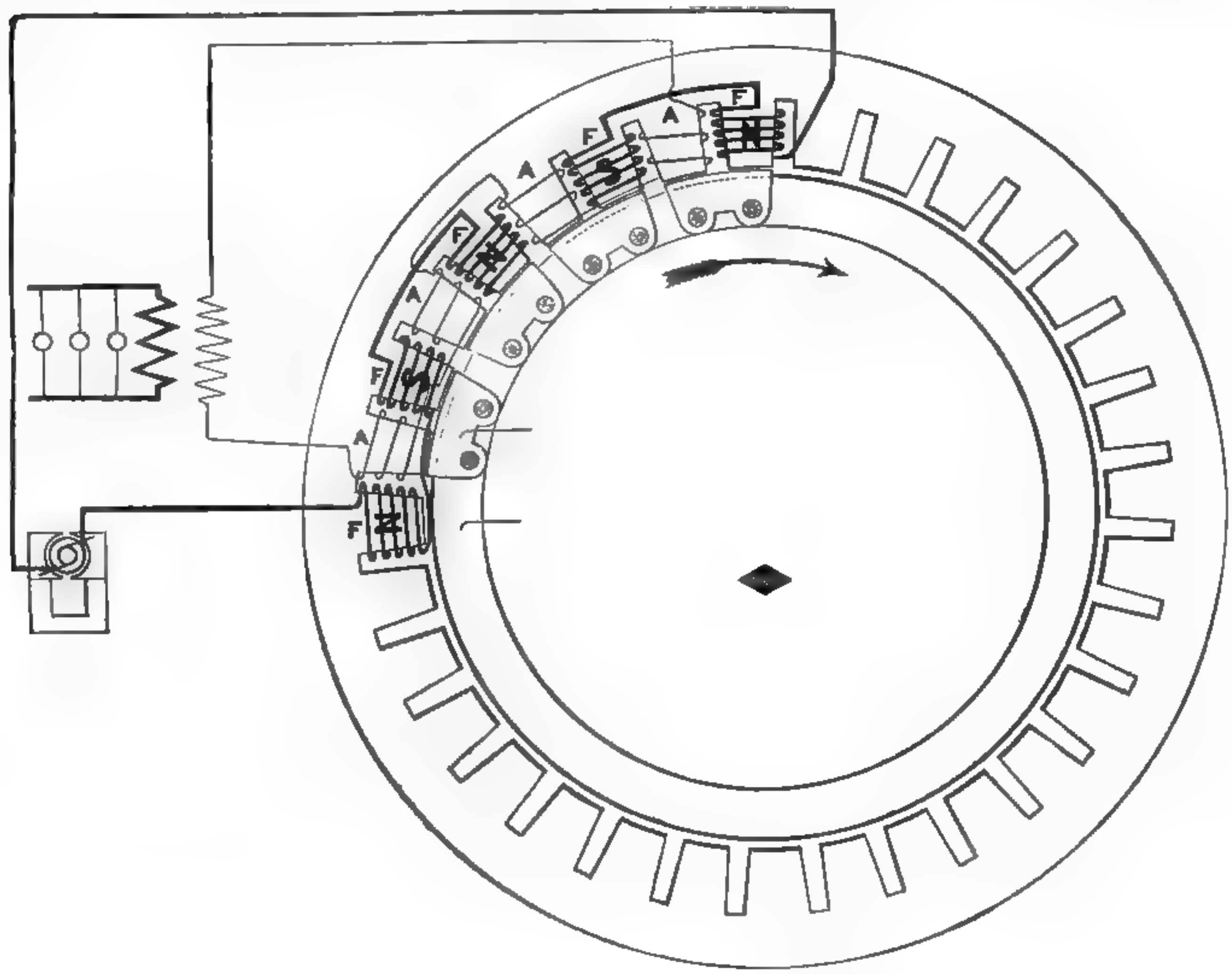


Fig. 8.

Most of the details of this machine can conveniently be taken from the adjoining list, but the following are not included: Diameter of outer ring of laminated iron 5ft. 7½in., width 1ft. 0¾in., the iron plates being ·042in. thick. The magnets are wound with 144 turns of ·200in. by ·063in. strip and connected in parallels of four in series. They are excited by a current of 80 amperes at 60 volts.

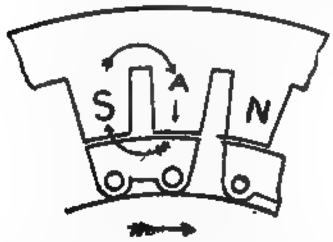


Fig. 9.

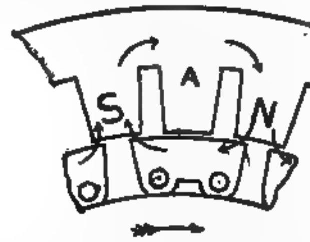


Fig. 10.

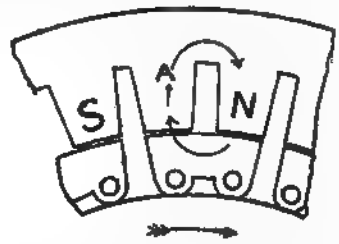


Fig. 11.

The adjoining list of alternators, of which I have already described the construction, will enable some idea to be formed of the relative advantages of the various types. The first few columns need no comment, but it is of interest to note the number of complete periods per second. The larger Kapp alternator, giving 100 periods, must be taken as an exception to the general practice.

COMPARATIVE LIST OF ALTERNATORS.

Name of maker.	Name of designs.	Normal. Revs. per minute.	Normal. Volts.	Normal. Amperes.	Normal. Kilowatts.	Complete periods per second.	Weight in tons.	Floor space. Length. ft. in.	Floor space. Breadth. ft. in.	Height. ft. in.	Kilowatts per ton.	Kilowatts per square foot floor space.	Revolving parts. Mean diameter. ft. in.	Revolving parts. Circumferential speed, feet per minute.	Magnets. Material.	Magnets. Number of poles.	Magnets. Section. in. in.	Magnets. Per cent. of output for exciting.	Armature. Material used for core.	Armature. Number of coils.	Armature. Conductor.	Armature. Number of turns per coil.	Armature. Total number of turns in series.	Armature. Number of parallel circuits.	Armature. Weight of conductors. lb. oz.
The Brush Electrical Engineering Company	Mordey	430	2,000	50	100	100	9·05	8 3	× 6 4	7 0	11·1	1·92	4 8	6,300	cast iron	14	—	2·0	porcelain	28	copper tape	—	—	2	—
	Mordey	600	2,000	25	50	100	4·00	6 7	× 5 6	5 3	12·5	1·39	3 4½	6,350	cast iron	10	8 × 4	—	porcelain	20	copper tape	—	—	1	—
The Electric Construction Corporation	Elwell-Parker	600	1,000	30	30	60	2·75	4 6	× 4 0	4 4	10·9	1·66	3 0	5,550	wrought iron	12	3 × 6	5·3	iron	12	·015 sq. in.	34	408	1	—
The Gulcher Company	Fricker	700	100	300	30	70	1·5	4 8	× 3 0	4 0	20	2·15	2 1	4,560	cast iron	12	10 × 5½	2⅝	iron	12	·08in. × ·162in	25½	25½	12	39 12
Johnson and Phillips	Kapp	900	2,060	7·5	15	75	2·25	4 9	× 3 0	3 9	6·7	1·08	2 6	7,100	wrought iron*	10	6½ × 4	—	iron	10	circular wire	—	—	—	—
Johnson and Phillips	Kapp	600	1,000	120	120	100	6·15	5 9	× 6 9	5 6	19·5	3·10	4 3	8,000	wrought iron*	20	4½ dia.	2·0	iron	20	2(·075 × ·230)	20	200	2	124 0
Ferranti	Ferranti	335	2,400	93	225	67	18·35	9 9	× 13 8	9 3	12·3	1·68	5 6	5,770	wrought iron†	24	12 sq.	2·0	brass & asbestos	24	·0394in. × ·025in	40	480	2	231
Siemens Bros.	Siemens	400	80	500	40	66	2·00	3 6	× 5 6	—	20	2·07	4 4	5,420	wrought iron*	20	—	—	wood	20	compressed strand	—	—	—	—
Woodhouse and Rawson	Kingdon	375	116	640	70	100	7·00	3 9	× 6 9	—	10·0	2·76	4 6	4,930	laminat'd iron	16	—	6·8	iron	16	·197in. × ·063in.	44	44	16	—

* The cores only are of wrought iron fitting into cast-iron frames.

† Cores of wrought iron cast in the frames.

of the English makers of this design, as it was built to a foreign order. Then, out of seven makers two have adopted the use of 100 periods per second, and the other five show an average of about 70. The hysteresis loss in iron-cored armatures increases with the frequency, and this forms a special reason for keeping it low. The great advantage of increasing the frequency is that the weight of the transformer can be reduced in proportion.

The output of the alternators given is that fixed by the makers, and as they may have widely different ideas of what the output should be fixed by, it is not a definite amount. Still, on comparing the outputs per weight and square foot of floor space, it will be seen that the figures do not vary much. It must be remembered that the Brush magnets are made entirely of cast iron, which is likely to make the output per weight quite 40 per cent. lower than if wrought iron was used. In this column three machines give the high figure of about 20 kilowatts per ton—namely, the Gulcher, the Kapp, and the Siemens. In the column showing the output per square foot of floor space, the order commencing at the highest, is Kapp, Kingdon, Fricker, Siemens, Mordey, Ferranti, and Elwell-Parker.

The mean circumferential speed of the armature or moving magnets is in each case much higher than that adopted in direct-current dynamos. The limiting safe speed is, of course, a function of the mechanical strength of the design. Messrs. Johnson and Phillips work at the highest speed, 8,000ft. per minute, and their construction of core is well able to stand this. The Brush Company's magnets have a circumferential speed of 6,300, and the other makers show an average of about 5,000ft. per second. The amount of power used to excite the magnets, and given in that column, is definite in all instances except the first. The Brush Company have not given the exact exciting power for each machine, but state that it averages about 2 per cent. As regards the material used for the core, four of the seven makers use iron, and the others use respectively porcelain, laminated brass, and wood.

The efficiency of each machine would form a most interesting calculation; but to enable the exact efficiency to be determined, a few more details—such as the polar area, the air gap, etc.—would be required, and it is not fair to publish approximations only. The losses due to Foucault current would also have to be determined, as this loss is likely to be a large item. Messrs. Siemens and Co. have adopted the laminated conductor, and Messrs. Johnson and Phillips have subdivided their armature conductor with a view to reducing this loss, but as yet will publish no particulars of what percentage loss they find due to this cause. The comparative hysteresis losses in the various iron-cored armature can be roughly obtained by comparing the quantities of iron used.

In conclusion, I have to thank the various makers for their courteous answers to my enquiries for particulars of their alternators.

EXPERIMENTS ON ELECTRICAL RESISTANCE.*

BY DAWSON TURNER, M.D.

The author had the pleasure when in Paris of seeing some of Mr. E. Branly's experiments on the influence of currents of high potential upon electrical resistance. He has since repeated some of these. It is well known that metallic powders present a very great electrical resistance. This can be lowered to an extraordinary degree by the passage of a spark in their neighbourhood. The author has tried, amongst other substances, powdered aluminium, copper, annealed selenium, iron filings, small shot, mixtures of aluminium and resin fused into a solid stick, etc. The best results were obtained with the first two. A short glass tube is filled with powdered aluminium, and placed, by means of copper wires passing through corks, in circuit with one or two cells and a galvanometer. The resistance of the aluminium is very great, and the needle of the galvanometer will remain at zero. If, however, a spark from an induction coil be passed anywhere in the vicinity, the

* Paper read before the British Association at Edinburgh.

resistance will become at once very much diminished, and the galvanometer needle will be deflected. Thus, though there was at first no appreciable current, there may now be one of 250 milliamperes. The powder will, if undisturbed, remain a conductor for some little time; but if the table be shaken, or the glass tube be moved, the initial resistance at once returns, and the needle passes back to zero. After the resistance has been once lowered in this way, the powder gets into a very sensitive condition—a spark at a great distance lowers the resistance, and the slightest jar restores it. The author was not successful with ordinary iron filings, perhaps because they were not sufficiently finely divided. Mere shaking does not restore the resistance of the solid stick of aluminium and resin, but the application of a little warmth is sufficient.

The experiments would appear to suggest that the molecules of the powders become arranged in such an order as to conduct electricity when an electrical discharge occurs in their neighbourhood, and that the slightest mechanical jarring suffices to destroy this arrangement. It does not appear to matter which way the induction current is passed.

PROF. EWING'S MAGNETIC CURVE-TRACER.

At his evening lecture on "Magnetic Induction," delivered on Monday last, and again on Tuesday, before Section A of the British Association, Prof. Ewing exhibited an apparatus for automatically drawing curves to exhibit completely the relation of magnetism to magnetising force in samples of any iron or steel.

Specimens of Curves obtained with Prof. Ewing's Curve-Tracer.

The apparatus can be arranged so that a complete H B cycle can be gone through in $\frac{1}{10}$th or even $\frac{1}{50}$th of a second, the result being a continuous line of light upon a screen.

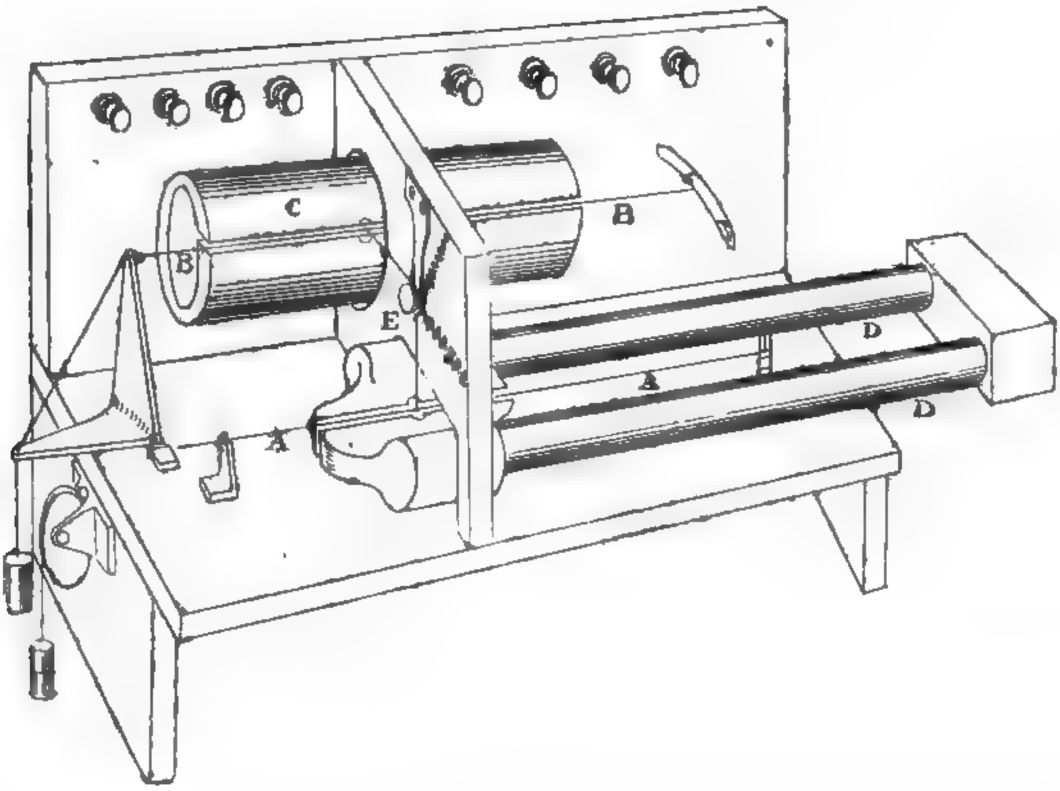


Fig. 1.

The principle of the apparatus will be seen at a glance. E (see Fig. 1) is a mirror, mounted with two degrees of freedom, capable of altitude and azimuth movement. It receives azimuth movement from the wire B B, which is stretched in a narrow gap in an electromagnet, C. It receives altitude movement from a wire, A A, which is stretched in a narrow gap between the pole-pieces of the magnetic circuit, D D, consisting of the rods to be examined. A constant current is passed through the wire A, and it therefore sags, up or down, proportionately to the field across the gap; in other words, proportionately to the magnetism of D D. The variable current which flows in the coils of D D passes also through the wire B. Hence, since the field of C is constant, B sags out or in, giving the mirror azimuth movement proportional to the strength of the magnetising current. B with its magnet, taken alone, thus forms an extraordinarily dead-beat galvanometer, and A forms an equally dead-beat magnetometer.

Small loops on the main curve can equally well be shown. In the form of the instrument suitable for slower use, it will allow of different materials being tested magnetically with the utmost readiness. A cycle can be obtained from an iron bar in a few seconds; then the bar can be taken out, and another bar put in, and its cycle drawn just above the previous one, so that a glance shows the relative hysteresis, relative permeability, and so forth—in fact, all that dynamo makers and transformer builders want to know about iron or steel. The whole process is quick enough and simple enough for workshop use.

Discussion.

Dr. Hopkinson referred to a series of experiments carried out by his son, and Lord Kelvin, Prof. Perry, and others made a few remarks, to which Prof. Ewing briefly replied.

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SYSTEM.

It is always understood to be the sole object in life of the country squire to put a ring fence round his landed estates. Similarly, the aim of some scientific men seems to be to connect everything in their particular branch of science under some rigid system. Thus the electrical man swears by his system of units, and anything that has not yet been brought into line must at the earliest opportunity be dragged in, no matter how doubtful it be whether another year with its records of progress will not show this particular haste to have been premature. In a progressive and undeveloped branch of science this haste is a nuisance. It is so electrically. We live in a period of constant change. The student of to-day wishes he had a name for some particular phenomenon, and to ease his conscience proceeds at once to coin one. A year hence fuller knowledge tells him the name wanted is for another phenomenon, and not for the one already named. Then to crown the edifice of Tantalus, the electrical student is a hero worshipper. The name of his particular Gamaliel must be handed down to posterity as one of the shining lights of a period which, when compared with the period over which scientific investigation has extended and will extend, is as nothing. His heroes are those immediately in front of his eyes. His allegiance to their infallibility is so great that although the whole theories of the science are changing, he cannot see that they may be wrong. Gilbert was a giant in his day, but how many of the present-time electricians know his work, except as contained in a big book under a glass case at some exhibition. No doubt the hero worshipper of Gilbert's time would have desired to have handed his name down to posterity in some such way as it is proposed to hand present-century names down to posterity. We imagine the better course to pursue it to follow the lead of the philologists, so that the word itself shall contain some indication of its meaning. The Greek, and perhaps the German, would have made a compound word to indicate pressure, current, energy, power. We can give the names volt and ampere, but kick against volt-ampere, a compound word, and favour watt—a term conveying in itself no meaning. Enough, however, of this word-coining, which might be tolerated, perhaps, especially when euphonious; but what is more important, is to insist upon a time of quietude. If changes in nomenclature are to be introduced at Chicago next year, let those changes be final for a quarter of a century. Elsewhere we give Prof. Lodge's suggestions, not as given at the B.A. meeting, but as intended to be given. As a matter of fact, the whole meeting was an example of presidential courtesy in saying time is short, therefore cut your paper or remarks short. Hence Dr. Lodge was hardly given a show. It was clear, however, that a mass of opinion was distinctly against change. If things are not perfect, let them slide. Make shift for a few years till we can see better what exactly is wanted. There may be some anxiety to have a perfect system, but when such men as Dr. Lodge admit that

the terms "watt" and "joule" are hardly necessary, it will be just as well, as Dr. Hopkinson suggested, to wait for further consolidation of the whole subject before introducing new or changing old terms.

LANE FOX AGAIN.

In our issue of April 8th we commented upon one of the points raised in the evidence given in this case. Notification was given us of an appeal, hence any further comments were impossible. The appeal has been tried, and judgment delivered, the original judgment of Mr. Justice Smith being upheld. There is still one more step which infatuated litigants may take—appeal to the House of Lords. Enough money has already been wasted—sufficient indeed to have put up a good-sized central station—and in our opinion needlessly wasted. Our contention all along has been that a clever man has attempted to ram down the throats of the industry, by the light of the knowledge of 1892, a patent that was of the nature of a fishing patent taken out in 1878. Bit by bit has been disclaimed, with the intention of leaving just those sentences which might be construed by a court of law as indicating knowledge and invention. We are glad that the attempt has failed, but it was almost a success. It would indeed have been a disgrace to our legal institutions if a patent which has largely been disclaimed, and the "invention" of which the patentee, when in a position to do so, never carried to success—we say it would have been a disgrace to have had such a patent upheld. In our opinion the best proof of the worthlessness of the "invention" is proved by the patentee's own action. When all-powerful with the old Father Brush Corporation, his efforts were not directed to the perfection of this now-claimed master patent, but to something else. We are speaking strongly because we feel strongly. An attempt has been made to coerce and hamper the whole industry because of the accidental rather than the conscious, intentional language used in the patent specification. As we pointed out at the time when Mr. Justice Smith's judgment was given, so exceedingly able were Mr. Lane Fox's advisers that it was made to appear that certain facts were well known in 1878, ..., for example, the use of the term "earth" for ...tallic returns. It will be seen that the appeal ...dges accept this as correct; also they accept as a ...covery of Mr. Lane Fox that a constant pressure ... or about 100 volts is something essential. Our ...ders, of course, know that there is nothing about ...0 volts to render such a pressure essential. But ...e irrational conclusions are all swept aside in ... finding the apparatus as described "won't ...rk." A simple way in order to save money, ...ld have been for the judge or judges to be able ... order an independent authority to run the Law ...rts installation on the method described by ... Lane Fox. This would have sufficed to prove ... real and true value of the apparatus. For...tely, or unfortunately, our opinions are not in ...rd with those expressed by some of our con...poraries, hence there is always the incentive ...use of such differences of opinion for a litigant to say, "The higher court may also have a different opinion to the lower court." Pity it is so, and that more money may possibly be wasted. We trust in this case Mr. Lane Fox has had enough of law, and will be satisfied with the verdict.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE DAY LOAD.

SIR,—You are continually pointing out in your periodical the necessity for a day load to electric lighting plants.

In a large district there must be several people who would utilise electricity for numerous purposes if they could get it without any original extravagant outlay, especially where their requirements are very irregular.

I suggest that the electric light companies might start a stock of accumulators and suitable transporting carts or waggons. These accumulators could be supplied in any quantity as desired at either regular or irregular intervals, and would form a probable stable support to the lighting industry.

The above may not be practical, but if you deem it to be so it might prove useful to some if inserted in your issue.—Yours, etc., R. S. WALKER.

St. Mary's Barracks, Chatham, Aug. 5, 1892.

[We heartily agree with the ideas expressed by our correspondent.—ED. *E. E.*]

A CONTRIBUTION TO THE THEORY OF THE PERFECT INFLUENCE MACHINE.*

BY J. GRAY, B.SC.

The history of the development of the heat engine appears to have repeated itself very closely in that of the electrical influence machine. The early experimental gropings of Savary and Newcomen, in the case of the steam engine, run parallel with those of Darwin, Nicholson, and others with the influence machine. These efforts resulted in machines certain, it is true, in their action, but, from ignorance of principles, very inefficient in their design. A closer study of the working of the steam engine and the application of higher principles by the genius of James Watt produced a machine of much higher efficiency, and left little for his successors to do except the perfecting of details, till another great advance was made in the theory of the heat engine. The labours of Holtz, extending over a period of 20 years, during which he worked out and perfected in infinite detail almost all the leading types now in use, has earned for him a good claim to be considered the Watt of the electrical influence machine.

The third stage in the development of the heat engine coincides with the rise in the science of thermo-dynamics; and the investigations of Carnot, Thomson, Rankine, and others showed that the heat cycle through which a mass of working fluid must pass in order to give a maximum efficiency must be made up of adiabatic and isothermal lines. An analagous principle to the above has been applied by Clerk Maxwell to the influence machine, for he has shown that the cycle of the perfect influence machine must be made up of what may be called equiquantic and equipotential lines, corresponding respectively to the adiabatic and isothermal lines of the heat-engine cycle.

The object of this paper is to describe some graphic methods which, I think, help to elucidate the action of Maxwell's machine, and to show by what amount the efficiency of the influence machine may be increased by the application of Maxwell's principles.

Maxwell points out that over and above the loss from leakage, there is a loss of energy in the influence machine through the sparking which takes place just before a carrier makes contact with the charging or discharging points in

* Paper read before the British Association at Edinburgh.

its course. The energy lost is $\frac{1}{2}$ Q V where Q is the quantity of electricity transferred and V the difference of potential producing the spark. The object of his invention is to do away with sparking. He effects this by causing the carrier of electricity to make contact with charging and discharging springs when its potential is the same as that of the spring in question, and to remain in contact during the whole time of charge or discharge.

Fig. 1 is a diagram which will serve to show the action of Maxwell's machine. Conductors are drawn in thick dark lines, and insulators left white, a convention in accordance with the electromagnetic theory of light.

The machine consists of six fixed hollow conductors, A, B, C, A^1, B^1, C^1, which may be looked upon as six sections of a hollow anchor ring, separated by insulating air spaces. A conducting carrier, P, is caused to revolve through the centre of the hollow conductors in the direction shown by the arrow. Three of the conductors, A, B, C, are connected to a Leyden jar of large capacity, charged to a positive potential, V. The other three conductors, A^1, B^1, C^1, are connected to another similar Leyden jar charged to a negative potential, V. The conductors taken in order round the ring are thus alternately positive and negative. The dotted line on the diagram is drawn to represent approximately the potential at each point of the circular path through the centre of the conductors along which the carrier, P, travels.

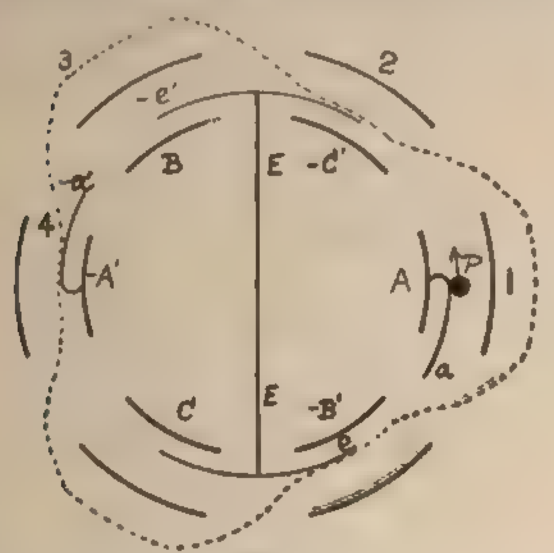


Fig. 1.

The potential at each point is indicated on the diagram by the distance (positive or negative) of the dotted line from the outer circle of the diagram. To the conductors A and A^1 are connected contact springs, a and a^1; and lying partly inside the conductors B and C^1 is a spring, e^1, connected to earth or to a similar spring, e, lying partly within the conductors B^1 and C.

The changes in the energy of the carrier, P, during one complete revolution and the work done upon it are best shown by a Q V diagram—*i.e.*, an energy or work diagram in which the components are the quantity and potential of the carrier.

Let Q O Q, V O V be the axes of co-ordinates: distances along O Q representing quantities of electricity on the carrier, and distances along O V representing potentials of the carrier.

We shall start with the carrier, P, as represented in Fig. 1, just about to break contact with the spring a, which is connected with the conductor A. The potential of the carrier will be equal to that of A, which we will represent by an ordinate, P N. Its quantity, due to its not being completely surrounded by the conductor A, may be represented by O P. As O P = V tan P N O, tan P N O equals (with proper units) the capacity of P with reference to the earth. Let tan P N O = α.

The point, N, on Fig. 2 corresponds, therefore, to the position of P on Fig. 1. In passing from its initial position till it comes in contact with the earth-spring, e^1, inside the conductor C^1, P retains its charge unchanged in quantity. We will suppose that S P represents the potential carrier, P, when about to make contact with the spring, if the conductor C^1 were removed. In o reduce the potential of P to zero, when it makes co the coefficient of induction, say, C^1 of the conduc upon P, must be such as to produce an equal and op quantity to O P on the carrier, P. Therefore

$$C^1 = \frac{\overline{OP}}{V} = \frac{\alpha V}{V} = \alpha$$

is the equation for determining the coefficient of ind which the conductor C^1 must exert upon the carrie the moment of contact.

The state of the carrier is now represented by th P on Fig. 2. The passage of the carrier along the e^1 is represented on Fig. 2 by the line, P T^1, during there is a gradual loss of quantity at zero potential carrier finally leaves the spring with a negative represented by O T^1. From contact with the sprin contact with the spring a^1 the quantity remains co but the potential falls—*i.e.*, we pass from T^1 to Fig. 2. Along the spring a^1 the quantity increases po or decreases negatively at constant potential, – V passes from M^1 to N^1 on Fig. 2. This completes o of a revolution, and the other half is exactly similar opposite—namely, along N^1 P^1 T M N back to the st point.

The work done on the carrier in one revolution is to twice the area of the rectangle, N T. A quantity of positive electricity is imparted to the conductor A equal quantity of negative to A^1; the potentials of quantities being V and – V respectively.

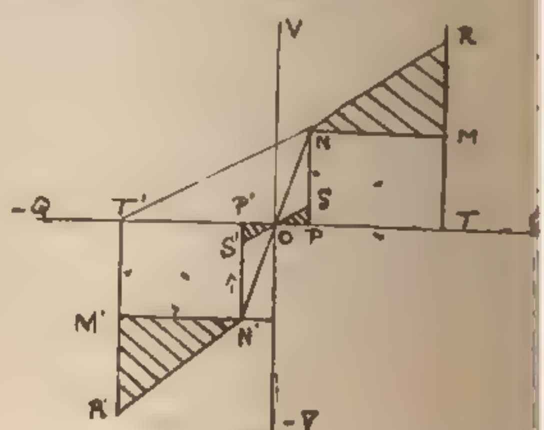


Fig. 2.

The efficiency of the machine in such a cycle is that is to say, there is no loss—friction, leakage, etc. left out of account.

The quantity produced per revolution is less th maximum possible by the amount left on P when it the discharging conductors, A or A^1.

The conductors C and C^1 are called by M regenerators, because their function is similar to that regenerator in a heat engine.

Let us now, in the first place, consider how mu efficiency of this influence machine is reduced b removal of the regenerators. The effect of remov will be to allow the carrier, P, to spark to the sp before making contact, and the energy dissipated spark is equal to the area of the triangle S P O. Th a similar loss in the other half of the revolution efficiency, E, will now be

$$E = \frac{QV}{QV + \frac{1}{2}\alpha V . \overline{SP}};$$

$$= \frac{1}{1 + \frac{1}{2}\frac{\alpha . SP}{Q}}.$$

This efficiency approaches unity as α or $\overline{SP}$ app zero, and in an actual machine α can be made very

Let us now, in the second place, consider the l efficiency due to replacing the long contact springs, a^1, by contact points inside the conductors A and A

approaching and entering the conductor A, the potential of P will not stop at M, but will rise to R before discharge.

If the capacity, a, is very small, and the conductors B^1 and A have equal coefficients of induction on the carrier, M R will be very nearly equal to M T. The energy dissipated in the spark is equal to the area of the triangle R M N. The efficiency would now be—

$$E = \frac{1}{1\frac{1}{2}} = \frac{2}{3}.$$

The absence of long contacts in the receivers thus leads to a much greater loss of efficiency than the absence of the regenerators.

CONTACTS		REGENERATOR	EFFICIENCY
CHARGING	DISCHARGING		
LONG	LONG	PRESENT	1
		ABSENT	$\frac{1}{1+\frac{aV}{Q}} = 1$
	POINT	PRESENT	$\frac{2}{3}$
POINT	LONG	ABSENT	$\frac{1}{1\frac{1}{2}+\frac{aV}{Q}} > \frac{2}{3}$
	POINT		$\frac{1}{2+\frac{aV}{Q}} > \frac{1}{2}$

If points are substituted for long contacts in the charging conductors, B and B^1, a moment's inspection will show that the loss by each spark is the area of the triangle P N T^1.

Then
$$E = \frac{QV}{\frac{1}{2}(Q+2aV)V};$$
$$= \frac{1}{1\frac{1}{2} + \frac{aV}{Q}} < \tfrac{2}{3}.$$

Finally, when all the contacts are points, as in the ordinary influence machine, the efficiency

$$E = \frac{1}{2 + \frac{aV}{Q}} < \tfrac{1}{2}.$$

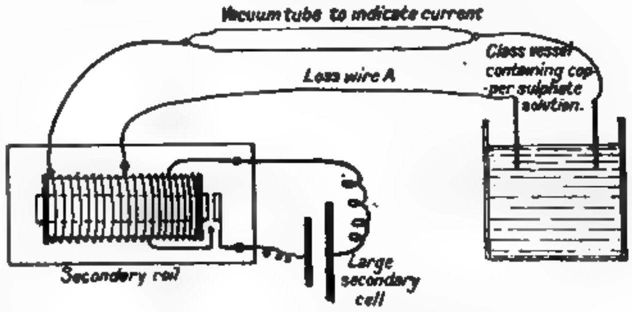
I have made a machine with long contacts, but without regenerators, which is self-exciting, and gives considerable quantity; but owing to difficulties of insulation, which I hope soon to overcome, I have not been able to get long sparks. These graphic methods may be applied to any influence machine for investigating their efficiency.

SOME EXPERIMENTS WITH A RUHMKORFF COIL.*

BY MAGNUS MACLEAN, M.A., F.R.S.E., AND ALEX. GALT, B.SC., F.R.S.E.

The quantity of electricity induced in a secondary circuit by a *make* in a primary circuit is equal to the quantity of electricity induced in the same secondary by a *break* in the primary. This fact was first experimentally proved by Faraday, and subsequent experiments and theory corroborate the statement. If, however, there is a non-metallic gap in the circuit, whether of air at ordinary pressure, or at much reduced pressure, as in vacuum tubes, the *break* impulse causes a flow in one direction, and the *make* causes either no flow or a much less flow in the opposite direction; because the short intense impulse of the former breaks down the resistance, while the comparatively long and less intense impulse of the make either does not break down the resistance at all, or only does so to a much less degree, so that the effective resistance is much greater in one direction than in the other. To obtain the average difference of quantity of electricity set in motion in one direction above that in the other, a copper electrolytic cell was put in circuit with a vacuum tube and the secondary coil of a small Ruhmkorff coil. The solution in the cell is sulphate of copper of density 1·17 with one-half per cent. of commercial sulphuric acid added. The electrodes were No. 36 B.W.G. copper wire (0·012 centimetre diameter), and they were immersed in the solution as little as possible, so as to get the best current density for the deposit. The mean of seven experiments lasting from two to four hours gives the average electrolytic current, calculated from the gain of the cathode electrode, as one-sixth of a milliampere. The gain of the cathode electrode was, in six of the seven experiments, greater than the loss of the anode electrode. An electrolytic cell was also put into the primary, and the mean ratio, in three experiments, between the gain of the cathode in the primary and the gain of the cathode in the secondary was 6,000. The mean current in the secondary was still about one-sixth of a milliampere.

One or two experiments were also tried without a vacuum tube in the secondary circuit, simply the electrolytic cell. Both electrodes showed loss. Again, a long thermometer



tube full of sulphate of copper solution was substituted for the vacuum tube. The resistance of this tube would be comparable to that of the vacuum tube. (A Thomson multicellular was put at the terminals of the vacuum tube, which showed 165 volts. This would give the effective resistance of the vacuum tube to disruptive discharges as $165 \div \frac{1}{6000}$ = one megohm.)

The few experiments done with this thermometer tube in the circuit are inconclusive, as sometimes both electrodes showed loss, and in an experiment lasting hours neither electrode showed either gain or loss. These last experiments are to be continued with slight modifications. It is also intended to attach a tube to an exhaust pump, and try these electrolytic experiments at different pressures, from atmospheric pressure down to very low pressures or very high vacuums.

* Paper read before the British Association at Edinburgh.

ON THE DIELECTRIC OF CONDENSERS.* †

BY W. H. PREECE, F.R.S.

Artificial cables are very useful adjuncts to the laboratory of the telegraph engineer. They not only enable him to experiment at his leisure, but they form very useful means to test and compare high-speed and delicate telegraph apparatus, and especially telephones. I have one, made some years ago, which has been in incessant use, composed of 54 inductionless coils of insulated copper wire, each giving 33 ohms resistance, and having a condenser of one microfarad capacity at the juncture of each pair of coils. This represented a circuit of a total capacity, K, of 54 microfarads, and of a total resistance, R, of 1,782 ohms—the K R being 96,228; this was equivalent to an ordinary submarine cable of 162 nauts length. It was not sufficient for our growing wants, and another similar set was recently made; but it did not give the same results. The resistances were exactly the same, but the individual capacities differed. This difference of about 5 per cent. was of itself of no practical consequence for the particular purpose for which the cable was constructed; but on carefully comparing the two "cables" with telephones, it was found that with the same nominal K R the one gave 30 per cent. better results than the other. This was a surprising and unexpected result. I thought it might be due to inductance, but none, neither *self* or *mutual*, could be detected.

The insulation, taken after one minute's electrification, of each was:

Old cable, 172·8 megohms per naut.
New „ 82·8 „ „ „

So that the difference was in favour of the old one. But

* Paper read before the British Association at Edinburgh.

† Lord Kelvin proposes to call this useful instrument a "Leyden," because the term "condenser" is applied to other more appropriate mechanical and physical apparatus.

the electrification of the new one was much less than that of the old one. The difference in the reading between the first and second minute, on the former, was one-twentieth of that of the latter.

Each cable was then rapidly charged and discharged 1,200 times, at varying rates, with an E.M.F. of 40 volts, and the cumulative remaining charge in each case read by deflection on a Thomson galvanometer. This was done by passing a 10ft. length of perforated slip through a Wheatstone's automatic transmitter. The following are the results:

Number of discharges per second.	Discharge.		Percentage difference.
	New.	Old.	
20	46	28	39
40	86	55	36
80	151	100	33
120	200	136	32
160	237	168	29

This clearly shows that the effect is due to absorption. Electrification, polarisation, and absorption are phases of electrolytic work done by the current upon the dielectric. The material itself, or the impurities contained in it, are slightly decomposed by the leakage current, a counter E.M.F. is set up which increases the apparent resistance (electrification), it gives a current of discharge reverse to that of charge (polarisation), it absorbs a quantity of electricity, the undissipated part of which is recovered as a discharge current. The condenser acts, in fact, like a secondary cell.

We are now using better paper than formerly, that made from the best linen rags, thinner tinfoil, and better wax, the best refined unadulterated white paraffin, having a melting point of from 125deg. F. to 128deg. F. Resin was formerly mixed with the wax, and when hot and liquid it was painted on the paper with a brush. The paper is now thoroughly dried and well saturated with wax by soaking under pressure, so as to get rid of all the moisture. Hence there is less electrification and less absorption, hence the difference. In the old type of condenser we observed a variation of capacity due to temperature, but in the new type this has disappeared. This effect of absorption on the effective capacity of the condensers and of insulated conductors is new to me, and as it may be new to many others I have thought it to be of sufficient interest to bring it before Section A.

It is a new term to be added to the equation of energy of compound circuits, and it has evidently a material influence upon the retardation of signals in long submarine cables. It has an equally important influence on the efficiency of telephone circuits, and it accounts partially for the great difference in my KR law between the observed effects of aerial and those of subterranean or submarine conductors. The former are always much superior to the latter. This would be due to the absence of polarisation in air, as well as to other electromagnetic and electrostatic causes. No work would be done on the molecules of air, no energy would, therefore, be absorbed, and no retardation of currents from this cause would ensue. An air dielectric is clearly the "Holy Grail" of the electrician.

ELECTRIC LOCOMOTIVES: SOME RESULTS IN ACTUAL WORKING.*

BY ALEXANDER SIEMENS.

The object of the present communication is to place on record the performances of two electric locomotives, the most powerful of their kind, which were supplied at the end of last year by Messrs. Siemens Bros. and Co. to the City and South London Electric Railway.

In the year 1888 the company, then called the City of London and Southwark Subway, issued a specification asking, among other things, for electric locomotives capable of developing a maximum of 100 brake horse power. Owing to financial considerations the contract was not placed with Messrs. Siemens Bros. and Co., although a perfect agreement had been arrived at on the technical points of the question.

The City and South London Company, however, invited Messrs. Siemens Bros. and Co. again in the beginning of last year to tender for locomotives in accordance with a specification practically identical with that agreed upon in 1888; and as a result two electric locomotives have been built and are now working.

Each locomotive carries two motors, and the use of all gearing is obviated by winding the armatures of the motors on the axles of the wheels of the locomotive. This method of construction was illustrated by a model shown at work at a meeting of the Society of Arts on May 18, 1881, and had been first suggested by Sir William Siemens, who, at the time of his lamented death, was actively preparing a proposition to work the Metropolitan Railway by electric locomotives.

The motors for the two locomotives were tested before they were fitted into their places by means of a Prony brake, and some of the results of this first set of tests are given in Table A.

TABLE A.

Speed in miles per hour	Electrical h.p. put into mot'r armature.	Electrical h.p. put into m'tor magnets.	Total electrical h.p. per motor.	Total el'ctrical h.p. per loco.	Brake h.p. measur'd	Effic'y per cent.
12·25	56·96	2·8	59·76	119·52	110	92
14·77	24·42	1·21	25·63	51·26	47·1	91·[illegible]
15·7	21·5	0·86	22·36	44·72	40·2	[illegible]
17·83	21·85	0·74	22·59	45·18	42·52	94·[illegible]
22·73	29·23	0·35	29·58	59·16	54·3	91·79
24·7	19·5	0·2	19·7	39·4	36·6	92·[illegible]
30·6	26·27	0·17	26·44	52·88	48·76	92·[illegible]

TABLE B.

—	Watt minutes.	Ampere minutes.	Total time including stops.		Mean volts.	Mean amperes.	A
Stockwell to City			min.	sec.			
Loco. No. 15. Journey 1.	322,660	768·65	14	40	419·7	52·[illegible]	[illegible]
" " Journey 2.	291,995	689·33	[illegible]	16	423·6	[illegible]	[illegible]
Loco. No. 16. Journey 1.	317,649	733·32	14	40	433·2	[illegible]	[illegible]
" " Journey 2.	315,660	751·32	14	50	420·15	[illegible]	[illegible]
Mean	311,968	735·65	14	36	424·16	[illegible]	[illegible]
City to Stockwell.							
Loco. No. 15. Journey 1.	323,065	766·05	15	30	422·5	[illegible]	[illegible]
" " Journey 2.	312,996	737·98	15	20	424·1	[illegible]	[illegible]
Loco. No. 16. Journey 1.	[illegible]	717·90	15	8	425·2	[illegible]	[illegible]
" " Journey 2.	321,660	740·31	14	56	[illegible]	[illegible]	[illegible]
Mean	315,910	742·83	15	15	[illegible]	[illegible]	[illegible]
Final mean	313,949	739·24	14	55	424·71	49·[illegible]	[illegible]

A. Average running speed, miles per hour exclusive of stops.

Since the two locomotives have been set to work on the railway they have had to keep the same time as the other so that their full power cannot be utilised, but it has been found that their efficiency is satisfactory in every respect.

Observations of the current and E.M.F. have recently been made simultaneously, by taking sets of readings of the ammeters and voltmeters, both at the generating station and on the locomotive. From these observations the curves accompanying these notes have been plotted. At the time these observations were made the locomotives had run about 8,000 statute miles, and on all four motors the brushes were wearing at the rate of about ⅛in. per 1,000 miles run; this small wear being a consequence of the motors running sparkless and practically without heating.

On examining the curves it will be noticed that there is no similarity whatever between those representing the volts at the generating station and on the locomotives respectively; this is, however, easily explained by the consideration that the volts at the generating station are influenced by all the trains in motion at the same time, while the volts on the locomotive are principally influenced by the demand of the locomotive itself.

* Paper read before the British Association at Edinburgh.

When the train is started, the current is regulated by the driver, so as not to exceed a certain amount, by means of switches inserting resistances into the main circuit, but these resistances are cut out within half a minute of starting, so that the waste of energy in the resistances is kept as low as possible.

Each locomotive, fully equipped, weighs 13½ tons, and the weight of the train of carriages it has to draw is about 21 tons. To this the weight of the passengers has to be added.

A summary of the results is given in Table B, which shows that the average power developed by each locomotive requires a current of not more than about 50 amperes, although in starting as much as 140 amperes are required.

This fact illustrates at the same time the peculiar difficulties which have to be grappled with in the construction of such locomotives, which have to work under conditions almost diametrically opposite to those of generating dynamos in electric supply central stations.

Discussion.

Prof. Unwin said he thought that at the present time there was hardly anything more important than the proper construction of electric locomotives.

Mr. Greathead, having described the nature of the line, said the steepest gradient was 1 in 30, and that on a sharp curve it would be seen that it is an exceptionally heavy one for all kinds of traction, except perhaps cable, for which the line was originally constructed. There were now four engines at the generating station, but two were sufficient, and when the traffic was light, one would be sufficient; there was therefore a large margin to allow for extension of traffic when the line was carried, as it was intended to do, to Clapham. He mentioned that the average load per train throughout the year was 51 passengers. The Siemens locomotives had worked very satisfactorily and without stoppage from any cause. There were 14 locomotives of the Mather and Platt make, and it was decided, after much anxious consideration, to adopt gearless locomotives. He mentioned that the Siemens armatures, after much running, had been found quite cold, and no repairs whatever had been necessary.

Dr. Silvanus Thompson said the motors as used were probably but an intermediate type between the small ones of the past and the larger ones of the future. It would be found necessary to build electric locomotives with big, heavy, and strong field magnets, and constructors must not be afraid of dead weight.

Mr. Traill said he was still using Siemens motors on the Portrush line, which were made in 1883, and the generators now in use were of eight tons.

Prof. G. Forbes wished to point out one or two causes of trouble in the past. Firstly, in the failures of the smaller armatures; these had been due almost entirely to heating, and consequent breaking down of the insulation. In the case of the City and South London Company's line the change of design was to a great extent responsible for the heating effect. The Professor here showed how the position of the field magnets, as originally intended, had been changed, and how parts of the field magnets had been cut away to allow for this change. He, as having originally suggested carbon for brushes, protested against the wrong use of carbon brushes, and advocated the use, not of one carbon but of several, each with an independent spring. Referring to the tables he called attention to the fact that all the trouble came in at the starting point, and not at the high speeds, and asked for further information from the author.

Mr. Alexander Siemens thanked the various speakers for their congratulations. He said in the generating station there were two machines, and there were also only two circuits. He was glad to know that Dr. Thompson considered that his company had made progress in electric locomotion. Respecting what Prof. Forbes had said, he thought a distinction must be made between those wound on the Gramme and those on the drum principle. As to carbon brushes he considered any kind of brush, whether of carbon, copper, or otherwise, if well made and used, there was no practical difference.

The **President** (Prof. Unwin) thought it was very generous of Mr. Siemens to give such good data for working as he had. He thought that the building of his armatures and big field magnets would eventually lead to the mechanical engineer being called upon to consider the question of the disaggregation of the axles of big motors. He then proposed the usual vote of thanks.

THE BRITISH ASSOCIATION COMMITTEE ON ELECTRICAL STANDARDS.

BY PROF. OLIVER J. LODGE, F.R.S.

In view of the hoped-for presence of Prof. von Helmholtz d other distinguished foreigners at this year's meeting of e British Association in Edinburgh, it will probably be cognised as suitable to take up and continue the discus- n on new electromagnetic units for practical purposes, ich was begun last year at Cardiff.

I therefore beg to contribute the following notes, and to conclude by moving some resolutions.

One great fact brought into prominence by the practical development of electricity is the analogy or reciprocity between the electric and the magnetic circuit, and this is the fact which it behoves us to emphasise in the naming of fresh units. The magnetic circuit has as yet no authorised names applied to it. The electric circuit is well provided, but perhaps one or two improvements can be made.

1. The Electric Circuit.

The first point on which I consider that practical men would do well to insist is that names shall be given to the complete things dealt with, rather than to mere coefficients. Thus of all units with which they are concerned there can be no doubt but that volt and ampere are the most prominent. These are the active things with which electrical engineers have to deal, and these are the things for which meters exist on every wall in an electric lighting station. The ohm, or unit coefficient of resistance, is comparatively academic in character; it is a constant of a coil of wire or of an underground lead; it is nothing vivid and active. The engineering use of the term ohm is mainly in connection with insulation and other high resistances; for large conductors the equivalent "volt per ampere" is perhaps more often used. It is the drop of potential which a given conductor entails for a given current that is of real interest to an engineer, and it is this of which in large leads he consciously thinks.

A six-ohm conductor means one that drops six volts for every ampere that is sent along it. If you send three amperes along such a line, the potential at the far end is 18 volts below that at the near end. The clear realisation of this fact would be almost aided by the complete title, six volts per ampere, instead of the abbreviation, six ohms. Nevertheless, the name ohm is in common use and hence may be assumed useful.

A still more useful name, however, for good conductors would really be the reciprocal of an ohm—the ampere per volt. Suppose this called a mo, as Sir W. Thomson once suggested, then a cable of 20 mos would be one that conveyed 20 amperes with a drop of one volt. A thousand-mo cable would convey 500 amperes with a drop of half a volt, and so on. It is more directly practical to think of the amperes conveyed per drop of voltage, than of the drop of voltage per ampere. I believe that some authorised name for unit conductance would be welcomed.

Units of Inconvenient Size.

The authorised name "coulomb" for unit quantity is barely used by engineers, who are content with ampere-hour, thus proving that what is needed in practical units is not so much a consistent decimal system, as a set of units each of practicable magnitude.

Farad.

The effort after consistency has resulted in the useless "farad"; and this should be a lesson not to try and fix units of unreasonable size. The C.G.S. units already exist as a consistent system; the only objection to them is that they are of unpractical size. The whole object of devising a practical system of units was to have things of everyday size to deal with. The volt, the ampere, and the ohm satisfy this condition. The coulomb, the farad, and the watt do not. Already they have practically given place to the ampere-hour, the microfarad, and the kilowatt.

Considerable more progress would have been made in knowledge of ordinary capacities if the microfarad had been called the farad, so that easy sub-multiples of it would have been available to express the capacity of Leyden jars, and such like things. The capacity of an ordinary jar would then have been a few millifarads, and a microfarad would have been the capacity of a short bit of connecting wire. I ask whether this change would introduce serious confusion even now. I think not. Nobody cares the least about "coulombs per volt," and so there is no sense or use in the present farad. Telegraphists would surely soon consent to drop the useless prefix micro, and the factor of a million is too great to render doubt possible as to what was intended, even in the transition stage. It ought to be regarded as essential to have the practical unit somewhere

not hopelessly away from the middle of the range of probable multiples and sub-multiples.

Coulomb.

A coulomb, again, is almost useless as a synonym for the ampere-second; it is so easy to speak of ampere-minutes or ampere-hours. If the name coulomb could be set free from its present superfluous meaning, it could usefully be applied to the electrostatic unit of quantity, which wants a name. Teachers would find it convenient at once, and in the apparently imminent line of development engineers might find it useful before long. It is the charge on a two-centimetre sphere at a potential of 300 volts (or on a 1ft. sphere at 20 volts). The capacity of the two-centimetre sphere would be $\frac{2}{10}$ of a (new) microfarad.

Watt.

Lastly, with regard to the watt. The name volt-ampere is almost as good as the name watt, especially since the watt is also one joule per second.

Both names—watt and joule—are not really wanted by electricians, to whom their coexistence is rather confusing. I believe it would be more convenient to use the term watt in the sense it gets so frequently used now—viz., energy, say, a volt-ampere hour; in which case a kilowatt would be synonymous with the present Board of Trade unit.

The rate of working, or power, could then be expressed in a rational and unforced way as so many watts per hour or so many volt-amperes. It is much more natural to give a name to a definite thing like a quantity of energy, than it is to give it to a mere rate of working. The latter is instinctively felt to need a reference to time; just as a velocity unit has not been practically found to need a name, being quite simply expressible in feet per second or miles per hour; and even when a name has been given, like "knot," instinct constrains people to practically get rid of it again by speaking of knots per hour, just as we find "kilowatts per hour" already often used in electrical workshops. I suggest, therefore, that the present watt is too small, that it is sufficiently expressed by a joule per second, and that it would be more useful if magnified 3,600 times, and turned into a unit of energy.

That we should thus have several energy units—the erg, the joule, and the watt—all of quite different sizes, is no objection, but an advantage, seeing the extreme importance of energy. Such things as length, mass, time, and energy demand a fair range of units. It would be tedious to express centuries in seconds.

2. Magnetic Circuit.

In speaking of the magnetic circuit I wish to refer back to my opening remarks concerning the electric circuit, and the class of things for which names should be found. In the magnetic circuit the only thing at present seriously attempted to be named is, in accordance with the historic parallel of the ohm, a coefficient or characteristic of a coil of wire—its coefficient of self-induction; the unit of which has been called variously a sechom, a quadrant, and a henry.

Total Induction.

But the real active thing with which engineers are concerned is total magnetic induction, total number of lines of force across an air gap, as between the pole-pieces or through the armature of a dynamo, or in the circuit of a transformer. It may be called the electromagnetic momentum per turn of wire, or the surface integral of B. This total induction is in some respects analogous to electric current, and has occasionally been called magnetic current (a bad name), or "magnetic flux." It is, however, more strictly analogous to the coulomb, and its time rate of variation is the more proper representative of electric current.

Its common practical name at present is "total lines," or "total induction," or "number of lines."

Now "one line" is awkward as a unit, besides being (if a C.G.S. line) inconveniently small. The earth, for instance, sends 4,400 such lines through every horizontal square metre about England. Through a square inch it only sends a fraction of a line. A practically sized unit of induction badly wants a name, and "henry" would have done for it very well, and have been both more suitable and more useful for the actual quantity than for a coefficient. But "henry" has already been half appropriated to the secohm, so, for illustrative purposes at any rate, I propose to use the name "weber" for the unit magnetic flux.

Concerning the most convenient size for the weber there is much to be said for making it 10^8 C.G.S. lines, though that is bigger than ordinarily occurs in practice, because then a wire which cuts one weber per second will have a volt difference of potential between its ends. Or a coil of 20 turns through which the magnetic induction changes at the rate of one weber per second will have an E.M.F. of 20 volts induced in it. The average E.M.F. in such a coil, spinning 30 turns a second, and enclosing a maximum total induction of one weber, is 600 volts.

This is the dynamo use of the unit; the following is the motor use.

A wire carrying an ampere and cutting a weber per second, does work at unit rate—viz., one joule per second.

Probably the simplicity of all this compensates for the rather unwieldy size of the unit. A strongly magnetised piece of iron may have 20,000 lines to the square centimetre; so a weber could occur across a narrow air gap half a square metre in area.

The earth gives an induction of about one weber through every 23,000 square metres of England, or 100 webers per square mile. The earth induction through a horizontal square metre is 44 micro-webers, so with micro and milli-webers the range would be fairly covered, though a smaller weber would have been better if it had been equally convenient as regards the volt.

The pull between two parallel centimetre square surfaces joined by a weber is $\frac{10^{16}}{8\pi}$ dynes, or 400,000 tons. A milli-weber gives less than half a ton pull; and a micro-weber less than half a gramme.

Because of the property that the voltage excited in a circuit is equal to the webers cut by it per second, a weber might be called a sec-volt. It is equal to a secohm-ampere-turn; that is to say, if a single turn of wire can have a self-induction coefficient of one secohm, it will excite a weber of induction for every ampere passing through it.

[Such a circuit in the form of an anchor ring would be enormous, something like a mile across; but it could be made in the form of a solid cylinder of best iron (μ = 2[illegible]), with an axial perforation for the wire, and 80 metres long.]

If a secohm coil has n turns, then an ampere passing through it excites only $\frac{1}{n}$th of a weber; for, since every turn encloses the induction, the latter is effective n times over, and so the induction coefficient is n times the induction per ampere, or n^2 times the induction per ampere-turn.

No name is needed for intensity (or density) of induction (B), for that can always be expressed in webers per unit area.

[For instance, strongly magnetised iron, with, say, 10,[illegible] lines to the square centimetre, has one-tenth of a weber per square foot, or 0.7 milli-webers per square inch.]

And there is a practical gain in thus leaving the specification of area open, for it enables British units of length to be employed in measuring air gaps, yokes, cores, and pole pieces.

So long as dynamo dimensions are commonly expressed in inches, there is no serious objection to specifying induction in fractions of a weber per square inch or per square foot.

Magnetomotive Force.

Now, consider the magnetic analogue of the volt, the unit of magnetic potential or magnetomotive force. By this is understood the line integral of the magnetising force H, the quantity, $4 \pi n C$, the step of potential once through and all round the circuit of a coil. It is a quantity most important in practice, and requires a name.

Mr. Heaviside has suggested the name "gaussage" as analogous to voltage, and if this were adopted the unit of magnetomotive force would be the gauss. The intensity of magnetising force would be the gauss gradient, or drop of gaussage per centimetre. No special name is needed for the unit of this quantity, H.

The common practical unit of gaussage at present is the ampere-turn, and this has several advantages. It may, however, be found better to make some convenient number of

engineers may be satisfied with and be willing to adopt. I need hardly say that I lay no stress upon the particular names here proposed In choosing them I have been influenced by such trivial considerations as the selection of a monosyllable to correspond with volt, and a dissyllable to correspond with ampere or coulomb

[With regard to Prof. Perry's footnote concerning college instruction and use of C.G.S. units, I suppose systems of teaching differ, but a senior student ought to be taught to deal with concrete quantities in so familiar a manner that no possible admixture of units can be any puzzle to him, nor involve anything worse than a little tiresome arithmetic.]

MECHANICAL UNITS.

There are several quantities in dynamics beside the joule and the watt for which brief names would be advantageous I do not propose to discuss these fully now, but the present opportunity might be utilised by agreeing to at least one unit, that of pressure—viz., the "atmosphere"; which might be defined as 10^6 C.G.S., or dynes per square centimetre, and stated to be equal to the pressure of a column of mercury 75 centimetres high at a specified temperature. The inconvenient pressure, 76 centimetres, might be spoken of as a Regnault atmosphere. I believe that a smaller unit of pressure, for instance, the micro-atmosphere or "barad," might also be usefully named. These pressure units will be useful for expressing energies per unit volume also, and the "barad," or whatever other name is decided on for the erg per cubic centimetre, is of reasonable magnitude for many purposes.

TRADE NOTES AND NOVELTIES.

Railway lighting is progressing Some time ago we were invited to inspect a railway reading lamp, and this gave considerable satisfaction, but we have not seen it in practice to any extent We believe such a lamp was shown a solitary one in the Entertainment Court at the Crystal Palace But now we learn that a special company has been formed, called the Railway Electric Reading Lamp Company, Limited (offices, 1 and 2, Great Winchester street), for the special purpose indicated, and we are informed that a contract, as result of two years' trials, has been made with the Metropolitan District

Railway for 10,000 reading lamps on their system The effect is shown in the illustration The gentleman in the corner reading the *Electrical Engineer* has, as is right, plenty of light, while the man reading the *Star* is in (physical) semi-darkness Each passenger can have his own light by putting a penny in the slot The apparatus was invented and perfected by M Tourtel. It is small, is only 5in by 3in, and after paying and pressing a knob, light burns for half an hour, sufficient for an ordinary suburban journey The lamp is 3 c.p., and can be turned about within certain limits The lamps will be placed under the hat-rail four in each compartment 16 to 20 lamps per carriage, all connected in parallel with a small set of accumulators by mains under the carriage. The lamps take ⅔ ampere each at 12 volts The battery is specially designed, consisting of six cells coupled in series, having a capacity of 72 ampere-hours They are enclosed in a strong wooden case, furnished with handles for easy removal, and duplicate sets are provided for each train A charging station is to be erected at Mill Hill Park, and sidings will be made for trucks for recharging the cells. Each truck will carry 28 batteries in four rows of seven, and each set of seven will be charged in series, with three series in parallel to the dynamo. The charging current will be 30 amperes (10 amperes per set) at 100 volts, the engine power for the whole being only 16 h.p. to 20 h.p. The cells will be distributed early in the morning, each charge being sufficient for two days. This method of distribution certainly has the advantage of being profitable, as each lamp taking 10 watts, for 1,000 watt-hours the company might receive 200d., or 16s. 8d., and this without cost of laying underground mains" As the railway company do not pay, and the average man will prefer electricity to a tallow candle no one is likely to object. The scheme is an interesting one, and let us hope will be a thoroughly successful one.

READING.

The following scheme for Corporation electric lighting works was brought before the Reading Town Council on Thursday last week -

A meeting of the committee of the whole Council (24 members being present) was held on Tuesday to consider a report from the Special Committee on the subject of electric lighting appointed by the Council on the 8th July, in consequence of a notice then submitted and proposed application by the Reading Electric Supply Company for a provisional order authorising the company to construct works and supply electric energy for lighting, motive power, and all public and private purposes within the borough. A letter was submitted from Messrs H and C Collins, solicitors to the company enclosing a copy of a letter from the Board of Trade, on the subject of the application by the company for a license under the Acts, to which the consent of the Council was recently given. The Board of Trade wrote that under circumstances explained they were not prepared to entertain the company's application for a license, but considered that the promoters should proceed by provisional order. The Special Committee met on the 21st July, and having considered the matter instructed the borough surveyor (Mr A E Collins) to prepare a report as to a suitable scheme to be embodied in a provisional order, and to obtain the assistance of an electrical engineer

At a meeting of the Special Committee, on Tuesday, a joint report was presented by Mr. J A. McMullen, A.M.I.E.E., and the surveyor, as to what would be a suitable scheme to be embodied in a provisional order, if the Council should determine to apply for such an order. We extract the following from the report -

"In considering the question of the advisability of the Council constructing and operating its own works for the supply of electrical energy, there are a few points worthy of especial attention The borough of Reading occupies such a good position in the financial world that it is enabled to borrow money much more cheaply than a company. The Council in carrying out works would not be tied in any way to buy the machinery or other plant of any particular manufacturer, but would be able to buy on the best terms The first object of the Council in constructing and operating works would be to supply energy at the lowest possible charge, due regard being paid to the ratepayers as distinct from consumers whereas with a company the first consideration would be that of dividend With works constructed and operated by the Council it is extremely improbable that establishment charges would approach the amount of such charges were the works in the hands of a company. The Council, as owners, would avail themselves of all improvements or economies in the generation or distribution of energy, and advantages gained thereby could be shared between the ratepayers and the consumers in the fairest possible manner. With regard to the general advantages of electric lighting in such a town as Reading, where good gas (16 candle) is sold at such a reasonable rate as 3s. per thousand cubic feet, the words of Prof Henry Robinson were quoted The cost of production per unit varies with the amount used With a generating plant capable of working 5,000 16 c.p. lamps at once it is estimated from the results obtained from existing installations, that the number of units sold would be [illegible] per annum The cost of producing electricity on this scale would be 3½d per unit, exclusive of interest and sinking fund, but including coal, oil, petty expenses, repairs, supervision, and [illegible] Interest and sinking fund would represent 1½d per unit, so that if 6d. were charged there would be a net profit of 1d per unit With a plant capable of supplying 10,000 16 c.p. lamps at once the cost of production would only be 2½d. per unit, or, including sinking fund, 3½d. per unit The Corporation could then supply at 4d. or 4½d and yet make a profit Electricity at 4½d. per unit is, light for light, equal to Reading gas at 4s. per 1,000 cubic feet With its enormous advantages it is always found that people are anxious to adopt the new illuminant at prices much higher than

previously paid for gas. Most London companies are charging 8d. per unit, equal to about 7s. per 1,000 cubic feet of gas, and yet their generating plants are taxed to their utmost capacity. At St. Pancras and at Bradford the local authorities are highly pleased with the result of their enterprise."

The district in Reading can be so selected as to be a very satisfactory one from the electrical and from the commercial points of view. The Corporation are in possession of what at present can be described as waste land in rear of St. Giles's Mill, which is eminently suitable for a central station. For so compact a district as that proposed for the area of compulsory supply, the best and safest system to adopt is the low pressure continuous current method, working on the three-wire system. [Reasons given.] The estimate is for a system of house-to-house supply on the above principle in the streets mentioned below: Friar-street, Blagrave-street, Valpy-street, The Forbury, West-street, Broad-street, Oxford-road (to Howard-street), St. Mary's Butts, Bridge-street, Southampton-street (to Crown-street), Crown-street, London-road (to King's-road), King's-road (to London-road), Queen's-road, London-street, Duke-street, King-street, Butter Market, High-street, Market-place, Minster-street, Gun-street, Castle-street, Cross-street. Should it be found necessary to extend the system of distributing mains in any direction, this can be conveniently done, and the pressure kept constant at the distant points.

Details having been set out, the report continued: The total cost of the scheme for house-to-house supply would be £37,000, including: Central station buildings, for 10,000 16-c.p. lamp plant; engines, dynamos, boilers, accumulators, testing and measuring instruments for 5,000 lamps; conduits under streets for 10,000 lamps; conductors under streets for 5,000 lamps. To increase the above house-to-house plant to the 10,000-lamp capacity would cost about £15,000, making the total cost of a 10,000-lamp plant £52,000. If it be considered desirable to light the streets named in the following list with 40 arc lamps, the additional cost would be £3,000, if the work were done concurrently with the house-to-house supply scheme, namely: Bridge-street, St. Mary's Butts, West-street, Friar-street, Market-place, Crown-street, Queen's-road, High-street, Broad-street, King-street, Duke-street, Southampton-street (to Crown-street), London-street, King's-road (to Eldon-road).

No amount has been estimated as the value of the site for the central station, that selected being the open almost waste land at the back of St. Giles's Mill. This land is Corporation property, and if detached from the mill it is not probable that the rental value of the mill would be materially reduced. The committee having considered the whole matter and consulted with the borough engineer and Mr. McMullen thereon, resolved to recommend as follows:

That the Council do not consent to an application by the Reading Electric Supply Company for a provisional order, but do determine to make application to the Board of Trade authorising the Council to supply electricity within the borough, and that the town clerk and the borough engineer, with the assistance of Mr. McMullen, be directed to take the requisite steps with a view to such an application being made in due course.

The committee approved the report, and recommended that the committee of the whole Council do meet again on September 8 next, and recommended to the Council that the committee be empowered to determine finally at that meeting as to the course to be taken by the Council on the subject.

The MAYOR moved and the DEPUTY MAYOR seconded the adoption of the minutes of this committee.

Mr. WELLMAN proposed an amendment that the question of the electric lighting of the town be considered at a public meeting of the Council instead of in committee. The matter was a very important one, involving an initial cost of at least £50,000.

Alderman KING seconded.

The amendment was unanimously agreed to.

LEGAL INTELLIGENCE.

LANE FOX v. THE KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY.

The Lane Fox Patents.

Judgment was given on Wednesday upon this appeal against a decision of Lord Justice (then Mr. Justice) A. L. Smith, sitting as a judge of the Chancery Division for Mr. Justice Romer during the illness of that learned judge. The action was brought by Mr. Lane Fox to restrain the defendant company from infringing the plaintiff's patent (No. 3,988, of 1878, for "improvements in obtaining light by electricity and in distributing and regulating the electric currents for the same, and in the means and apparatus employed therein." Mr. Justice A. L. Smith gave judgment for the defendants, holding that the patent was bad on the grounds that the complete specification did not conform to the provisional, that the invention, as described, could not be made to work, and that, if it could, no sufficient information was given as to how it was to be made to work. His Lordship, however, said that had the plaintiff been able to surmount the above difficulties, and had he established that by his invention he could have brought about what the Attorney-General said he could, his Lordship would have held that the plaintiff's invention was the subject-matter of a patent, that it had not been anticipated, and that the defendants had infringed it. (*Vide* the *Times* of March 31st last and the *Times* Law Reports, vol. viii., p. 467.) The plaintiff appealed. The appeal was argued at the end of June and the beginning of July by the plaintiff, on his own behalf, and by Mr. Roger Wallace (with whom were Sir H. Davey, Q.C., and Mr. Finlay, Q.C.), for the defendants. At the close of the arguments the judgment of the Court was reserved.

The Court now dismissed the appeal.

Lord Justice Lindley read the following judgment: This is an appeal by the plaintiff against a judgment of Lord Justice A. L. Smith dismissing an action brought for the infringement by the defendants of a patent belonging to the plaintiff. As usual in such cases, the defendants denied the infringement, and denied the validity of the plaintiff's patent, on the ordinary grounds of want of subject-matter, want of novelty, want of utility, insufficiency of the specification, and, in addition to these, the defendants contended that the nature of the invention, as described in the provisional specification, was not the same as that described in the complete specification, at any rate after it had been amended and put into its present form. Lord Justice A. L. Smith decided in the defendants favour on the last point, but he also came to the conclusion that the invention, as described, could not be usefully worked; and that the directions to work it were insufficient. He, however, decided the other points in favour of the plaintiff, and held that, if the patent had been valid, the defendants would have infringed it. A cross notice of appeal was given by the defendants, and the whole case was argued at great length before this Court by Mr. Lane Fox in person on the one side, and by Mr. Wallace, as counsel for the defendants, on the other. The Court was supplied with a printed copy of the shorthand writer's notes of the evidence taken in the Court below, of the arguments of counsel on the trial of the action, and of the judgment of the learned judge. All these I have carefully read and studied since the argument in this Court was closed. The plaintiff's patent, as described in his original specification, was for "improvements in obtaining light by electricity, and in conveying, distributing, measuring, and regulating the electric current for the same, and in the means or appliances employed therein." The provisional specification was filed on October 9, 1878, and the complete specification was filed on April 9, 1879. Owing to subsequent disclaimers and amendments, which it will be necessary to examine more carefully by-and-by, the only part of the patent which has to be considered is that relating to the distribution and regulation of electric currents for purposes of lighting. In order to understand the nature of the plaintiff's invention and the objections taken to the validity of his patent, it is necessary to ascertain what was the state of knowledge as regards electric lighting in 1878. This is by no means an easy matter, for since that time much has been learned, vast improvements have been made, and the progress has been so fast, and yet so gradual and continuous, that there is great danger of supposing that what is plain and well known now was plain and well known then. The evidence given in the case shows that the following matters were well known in 1878: First, that electricity could be used for lighting purposes; second, that the arc or Brush light was known and in course of being perfected; third, that incandescent lighting was foreseen as possible and probable, and that many persons were trying to discover how to effect it; fourth, that electric generators, and what are now called dynamos, were well known; fifth, that Planté's secondary batteries capable of being charged by an electric current, and of storing electricity (*i.e.*, of remaining inert), and of giving electricity out when wanted, were well known and had been used for arc lighting; sixth, that the voltage of the electric current given off by such batteries could be increased or diminished by adding or removing cells; seventh, that in order to obtain and maintain an electric current a complete conducting circuit was necessary; eighth, that for currents of low tension the earth itself might be used for a return conductor; ninth, that "earth," or "an earth," was a technical expression used to denote any suitable return conductor; and, tenth, that any competent electrician would know that, if in any particular case he could not use the earth itself as a return conductor, some other return conductor would have to be provided. On the other hand, the evidence shows that in 1878 it was not known how to construct an incandescent electric lamp for any generally useful purpose. It was not known to be important for the purpose of lighting with such lamps that the current supplying them should be kept at a constant pressure of about 100 volts; nor was it known that good results for incandescent electric lighting could be obtained by using secondary batteries, such as Planté's, in conjunction with dynamos. Further, in 1878 dynamos did not work so smoothly as they do now, and some better method of regulating the action of the engines used to drive them was necessary, or at least desirable. Lastly, it was not known that, for lighting large districts with incandescent lamps with electrical currents of high tension, the earth could not be used as a return conductor. Such being the state of knowledge in 1878, the plaintiff claims by his patent to have done three things which were new and useful: viz., (1) he claims to have invented a lamp which would answer the purpose; (2) he claims to have invented a method of keeping the E.M.F. of the current in the mains constant at about 100 volts; (3) he claims to have invented a method of better regulating the engines which drive the dynamos. The lamp has been since replaced by cheaper and better ones, and has been disclaimed. The regulator has become unnecessary by reason of improvements in engines and dynamos, and has been disclaimed, but it was a very important part of the

plaintiff's original invention. There remains the invention for keeping the E.M.F. of the current in the mains constant. This invention is the one which has to be considered in this action. An invention is not the same thing as a discovery. When Galvani discovered the effect of an electric current from his battery on a frog's leg he made a great discovery, but no patentable invention. Again, a man who discovers that a known machine can produce effects which no one knew could be produced by it before, may make a great and useful discovery; but if he does no more, his discovery is not a patentable invention. "Britain v. Hirsch" (5 Pat. Cas., 232), "Harwood v. Great Northern Railway Company" (11 H.L.C., 654), "Horton v. Mabon" (12 C.B.N.S., 437), "Saxby v. Gloucester Waggon Company" (7 Q.B.D., 305). He has added nothing but knowledge to what previously existed. A patentee must do something more; he must make some addition, not only to knowledge, but to previously known inventions, and must so use his knowledge and ingenuity as to produce either a new and useful thing or result, or a new and useful method of producing an old thing or result. On the one hand, the discovery that a known thing, such, for example, as a Plante battery, can be employed for a useful purpose for which it has never been used before is not alone a patentable invention; but, on the other hand, the discovery how to use such a thing for such a purpose will be a patentable invention if there is novelty in the mode of using it, as distinguished from novelty of purpose, or if any new modification of the thing or any new appliance is necessary for using it for its new purpose, and if such mode of user, or modification, or appliance involves any appreciable merit. It is often extremely difficult to draw the line between patentable inventions and non-patentable discoveries, but I have endeavoured to state the distinction as I understand it, and so far as is necessary for the purposes of the present case. I have, of course, been guided by the previous decisions on the subject, and especially by "Harwood v. Great Northern Railway Company" (11 H.L.C., 654), which is the most instructive of them all. I have been induced to make these observations in order to apply them to the question, whether the plaintiff's invention is anything more than a discovery that Plante's cells can be usefully employed for incandescent lighting. If it is not, his invention will not be the subject matter of a patent. What, then, is the nature of his invention as described in his original specifications? It certainly is not for the mere use of Plante batteries in connection with dynamos. It is for the use of them as described, which is a very different matter. His Lordship referred to the provisional and complete specifications, and continued: I cannot read these specifications without coming to the conclusion that the plaintiff thought he had discovered how to overcome one of the greatest difficulties in incandescent lighting. He points out that the E.M.F. of the electric conducting mains should be kept constant at about 100 volts by means of dynamos and secondary batteries, used as described at various places, and in conjunction with the regulator, which, he says, is necessary. That is his discovery and the nature of his invention as stated by himself. It is not put in this simple form; it is mixed up with the mode of carrying the invention out. The plaintiff not merely discovered that Plante's secondary batteries could be usefully employed for incandescent lighting, but he showed the importance of keeping the E.M.F. in the mains constant at the best voltage, and he claims to have shown how, practically, the desired result could be obtained, which no one knew before. As regards the nature of the invention as originally described, and as regards its being the proper subject matter for a patent, my decision is in favour of the patentee, provided always that his invention proves practicable. This accords with the view taken by Lord Justice Smith. But this view of the plaintiff's invention is of no use to the plaintiff, for neither the defendants nor anyone else use this invention as it was originally described. The plaintiff now claims something very different, viz., the use of secondary batteries in conjunction with dynamos for the purpose of keeping the E.M.F. constant in the mains at about 100 volts. Lord Justice Smith held this to be an invention very different from that originally described, and he also held that if this was the plaintiff's invention it would not work without modifications and precautions which the plaintiff never pointed out. I agree with him on both points, and I will take the last first. It is, I think, clear that no one had ever shown or professed to show how to produce this desired effect before 1878. Many prior patents were referred to by the counsel for the defendants to show want of novelty in the plaintiff's invention, but there is no trace in any of them of any method of keeping the E.M.F. in a main constant at any particular voltage, nor was that the object of any of them. I dismiss them all with that short observation. I pass from the novelty to the utility of the alleged invention and to the sufficiency of the specification for carrying it out. The utility of the alleged invention depends not on whether by following the directions in the specification all the results now necessary for commercial success can be obtained, but on whether by such directions the effects which the patentee professed to produce could be produced and on the practical utility of those effects. Can it be said that the invention as described in the amended specification was in 1878 a practically useful addition to the then stock of inventions? To judge of utility the directions in the amended specification must be followed, and, if the result is that the object sought to be attained by the patentee can be attained and is practically useful at the time when the patent is granted, the test of utility is satisfied. Utility is often a question of degree, and always has reference to some object. Useful for what? is a question which must be always asked, and the answer must be, useful for the purposes indicated by the patentee. See per Lord Chief Justice Tindal in "Cornish v. Keene" (1 Webst. Pat. Cases, 507); Edison v. Holland (6 Pat. Cas., 243); "Badische Anilin Fabrik v. Levinstein" (12 App. Cas., 712, 719, 720). An invention may be useful as indicating the direction in which further progress is to be expected, and yet that same invention may be useless for any other purpose; useless, that is, as an invention without further developments and improvements which have not occurred to the patentee. This is, in my opinion, the real truth with respect to the plaintiff's invention as now claimed by him. He made a distinct and important step in advance. The plaintiff was the pioneer, he showed others the road to be followed, but he did not give the traveller the information necessary to enable him to travel on it. There were difficulties to be overcome which the patentee did not foresee, and against which he naturally made no provision. There is an enormous mass of conflicting evidence upon the possibility of obtaining practically useful results by following the directions contained in his specification. Much of the evidence adduced against the patentee merely goes to show that by following the directions in the specification you cannot produce such good results as are produced by the defendants. This, obviously, is wholly immaterial. But there is, besides, a great deal of evidence to show that an electrician of ordinary skill would not have produced any useful result in 1878, if he simply followed the directions contained in the specification, as amended, with such variations only as an electrician of ordinary skill would have known how to make in 1878. So much more can be done now with a Plante battery than was suspected in 1878, that I have found the greatest difficulty in coming to a conclusion on this all-important question, and I much regret that we had not the assistance of an expert in electrical science. I have studied the whole evidence with all the care I can bestow upon it, and have come to the conclusion that the plaintiff had not, in 1878, invented what he now says he had—viz., a practical method of keeping the E.M.F. in the mains constant at about 100 volts, by means of secondary batteries and dynamos used simultaneously as described. The evidence adduced by the plaintiff shows that something like his invention can be worked on a small scale, and to a limited extent, when it is not necessary to charge the [illegible] so as to produce a high pressure when the lamps are connected with the main. Prof. Barrett's evidence as to what he did in his own laboratory for six years shows this; and it must be borne in mind that for a time he used water pipes and the earth as a return conductor, and showed them to be sufficient. But his voltage was low; his dynamo produced a current at a tension sufficient for his lamps, without the aid of secondary batteries, and he used his batteries as reservoirs rather than as regulators. Moreover, Prof. Barrett did not produce these results earlier than six or seven years ago, when much more was known about what could be done with Plante batteries than was known in 1878. The other cases in which the plaintiff endeavoured to prove that his invention was practically succeeded will be found to have involved considerable important departures from his invention as described. The installation for Lady Conyers' ball is the best case the plaintiff has, but there the batteries were taken charged, which is a very important matter. The defendants have, in my opinion, succeeded in proving that the lamps will be destroyed, if, whilst they are connected with the main, the batteries are charged at a sufficient voltage to work for any useful purpose. This objection to the patent goes to the root of the plaintiff's alleged invention. The objection is said by the plaintiff to be based upon the erroneous assumption that the batteries must be charged and emptied to an extreme extent. "Charging" and "discharging" are, no doubt, relative terms, to be understood within reasonable limits, and a man intelligent enough to seize the idea of the patentee would perhaps know, in a general way, that the E.M.F. could be regulated and kept approximately constant without excessive charging or discharging, and the brightness or dimness of the lamps would be his guide. But, conceding this, I think it proved that high charging is necessary to keep the E.M.F. constant and at anything like 100 volts, and, if necessary, it is not disputed that the lamps will be destroyed if the batteries are charged when the lamps are on, unless precautions against this cause of failure are taken. None, however, are indicated in the specification. I think it proved that a small variation in pressure in the main will cause current to go into, or come out of, the secondary battery, for a very short time. But this is not enough for practical purposes. High charging being necessary, it is, in my opinion, proved that the plaintiff's invention will not work without switches, and these are not mentioned in the specification. Upon this point there is much conflicting evidence, attributable, in great part at all events, to the ambiguity of the term "switching." It was known before Plante invented his secondary batteries that the voltage of primary batteries could be increased or diminished by increasing or diminishing the number of cells. The mechanical means of doing this is called "switching," and Plante himself pointed out that the voltage of his secondary batteries could be increased or diminished by similar means. Regulation, to some extent, takes place without switches. It is admitted by the defendants' own witnesses that the batteries have a steadying effect for a short time; they act as regulators to some small extent, and Prof. Barrett has produced satisfactory results in his laboratory with low voltage without switches. In Lady Conyers' case there were no switches, but there was no dynamo at work. On the other hand, the evidence convinces me that, for practical lighting with an E.M.F. of about 100 volts, and with dynamos, batteries and lamps all in use, switching is essential, and that no ordinarily competent electrician would have known, in 1878, how to keep the E.M.F. in mains constant at about 100 volts without further instructions than the plaintiff gave him. The plaintiff's claim to have invented, in 1878, a practically useful [illegible] keeping the E.M.F. in the mains constant at about 100 volts

whilst the dynamos are running and the batteries are being charged and the lamps are on, cannot, in my opinion, be sustained. This is the broad ground on which the patent, as amended, must be held invalid, and this was the ground on which Lord Justice Smith condemned it on its merits. Having arrived at this conclusion, it is unnecessary to consider the objections taken to the specification on the ground that the directions about the earth were misleading; and the direction that the cells of the batteries should have very large conducting plates was too indefinite. I have hitherto made no allusion to the plaintiff's regulator, but this was, in my opinion, an essential part of his original invention. He says in his original specifications that it is necessary. Necessary for what? The context shows that it was necessary to keep the E.M.F. in the mains constant. This was a mistake, and the regulator, and all that was said about it, has been disclaimed and struck out by amendment. But the effect of this is entirely to change the nature of the invention as described in 1878, and to enlarge it, which is not permissible. See "Gaulard and Gibb's Patent" (6 Pat. Cas., 215). In the original specification the plaintiff drew a marked distinction between storing and regulating; the secondary batteries were for storing, the regulator was for regulating. It is true that storing involves of necessity a certain amount of regulation; but, over and above such regulation as is necessarily incidental to storing further regulation was said by the inventor, in 1878, to be necessary for his invention. Between 1878 and 1883 he discovered that the regulator was not wanted, and that everything could be done by secondary batteries as used in 1883, by which time dynamos and switching had been greatly improved. He accordingly disclaimed the regulator. I am satisfied that the plaintiff had no idea that he could do without the regulator when he obtained his patent. He learnt it afterwards; and by disclaiming the regulator and amending his specification in 1883, as he did, the plaintiff essentially changed the nature of his invention for keeping the E.M.F. in the mains constant. The claim to the use of the batteries as reservoirs had a definite meaning in the original specification, but it has a different and much wider meaning in the specification as amended in 1883. The plaintiff is now really claiming a patent for the mere use of Planté's batteries in conjunction with dynamos. Such a patent would not have been valid unless the patentee had done something more. He must have shown how the two were to be successfully worked together. But assuming that a patent for such an invention might have been obtained, the plaintiff's patent was not granted for any such invention. The effect, therefore, of the disclaimer and amendment made in 1883 has been to destroy the validity of the plaintiff's patent, if it ever could have been made to work. Upon this point again I agree with Lord Justice Smith. It is needless to consider the question of infringement. I will only add that if the plaintiff's patent could be upheld as a patent for the use of secondary batteries in combination with dynamos, then the defendants would obviously have infringed his patent. But unless his patent can be upheld to this extent, no infringement has taken place. Convinced, as I am, that the plaintiff made a great step in advance when he suggested the application of Planté's batteries for the purposes of incandescent electric lighting, I feel bound to hold his patent invalid, on the ground that it was granted for an invention very different from that which he now claims to have protected, and on the ground that it was not in 1878 useful for the main purpose for which it was intended—viz., the practical lighting of large districts, and upon the ground that his specification was insufficient to enable an electrician of ordinary competence and skill in 1878 to carry it out without further experiments and invention, as distinguished from mere practice and increased dexterity and skill. The appeal, therefore, must be dismissed with costs, in the usual way.

Lord Justice Lopes said that he agreed, and had nothing to add.

Lord Justice Kay read a judgment to the same effect.—*The Times.*

COMPANIES' MEETINGS.

CITY AND SOUTH LONDON RAILWAY COMPANY.

The half yearly general meeting of this Company was held last Friday at Winchester House, Mr. C. G. Mott presiding.

The **Chairman**, in moving the adoption of the report, stated that during the past half year the steady increase in their traffic had continued, and the position of the Company had decidedly improved. They had carried in the past six months 2,813,000 passengers, or about 400,000 more than in the same period of 1891, and their season ticket holders represented an additional 100,000 passengers. He considered this increase especially gratifying, remembering the curiosity which would be naturally shown in such an undertaking at the outset of its working, and also the large amount of traffic which they obtained through the omnibus strike in the first half of 1891. The receipts, too, had increased from other sources besides passengers—rents, etc.; and the proportion of the expenses had decreased from 79 per cent. in the first half year of their working to 76 per cent. in the second half and to 70 per cent. in the past half year. He hoped the decrease in the expense would continue until they came down to a really satisfactory figure. In the first half year of their working their earnings paid their expenses and their debenture interest; in the second half they were also able to pay the full dividend on their preference shares; and in the past half year they were able to pay a dividend at the rate of ½ per cent. per annum on their ordinary shares and to carry forward a larger balance than they brought forward. He wished their progress was more rapid, but they must remember that all sound businesses had to be worked up by slow degrees and by hard work and good management. He believed there was no better and more permanent mode in which capital could be invested in this country than in a purely passenger line in the metropolis if the cost of the line were commensurate with the probable income to be derived from it. The amount at the credit of profit and loss account would have sufficed to pay a dividend on the present occasion at the rate of ¾ per cent. instead of ½ per cent. on the ordinary shares, but the Directors had thought it much more in the interest of the Company to carry forward a larger balance. He then went into the details of the accounts and of the working of the past half year, and stated that their expenses per train mile had been reduced from about 9d. in the first half year of their working to 7·7d. It had to be remembered that, in addition to the working of an ordinary railway, they had the lifts and the hydraulic apparatus for taking their passengers to and from the surface to their trains, and this involved considerable difference in the cost of working their undertaking. During the past year a joint committee of the two Houses of Parliament was appointed to consider the best method of dealing with the various electric and cable railway schemes in the metropolis proposed to be sanctioned by Parliament. The committee reported strongly in favour of these schemes, both as to their construction and their working by electricity; and they suggested that in future it would be desirable to give to such schemes easements under property where they did no damage at a small cost without the necessity of following the lines of the streets. If this suggestion were approved by Parliament much more direct and better railways could be constructed at a diminution of cost. The Bill promoted by this Company for extending their line to Islington and getting rid of the inclines under the river could not be proceeded with further than the second reading in the House of Commons owing to the dissolution, but it was carried over to the present session, and, with other private Bills, would be proceeded with at its present stage.

Mr. Sampson Hanbury seconded the motion.

The **Chairman**, in answer to questions, stated that the attention of the Directors was being closely given to the question of adding to the accommodation of the line and of improving the service generally.

The motion was adopted, the dividends were declared, and resolutions were also passed sanctioning the issue of debenture stock to the extent of the Company's authorised borrowing powers (with the view to converting the present terminable mortgage bonds into perpetual debenture stock), and approving the issue of a further £5,000 of the preference shares created by resolution dated June 30th, 1891.

BUSINESS NOTES.

Great Northern Telegraph Company.—The receipts for the month of July were £23,900.

City and South London Railway Company.—The receipts for the week ending Aug. 7th were £919, against £822 for the same period of last year, or an increase of £97.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino Brazilian Company, were £2,771.

Personal.—We understand that Mr. C. E. Spagnoletti, the electrician to the Great Western Railway, has resigned that appointment, and has accepted a seat on the Board of the Phonopore Company, Limited, as managing director. He, however, continues consulting electrician to the Great Western Railway.

Burglar Alarms.—Orders for the West-end, in electric bell and fire and burglar alarm department, are reported by Messrs. Evans, Stewart, Palmer, and Co., of Carnaby-street, to be unusually numerous this holiday season. This firm have recently fitted up Westley-Richards, the gunmakers, of Bond-street, with electric light.

Asbestos.—The Lords of the Admiralty have again awarded the United Asbestos Company, Limited, the contract for the supply of all asbestos goods required in the Royal Navy during the ensuing 12 months, the principal articles being "Victor" block packing, "Victor" metallic packing, and hard spun yarn packing for glands, "Victor" metallic sheeting, tape, rings, ovals, etc., for steam and hydraulic joints, asbestos millboard, asbestos tape, covering for steam pipes, etc.

Pioneer Telephone Company, Limited.—An extraordinary general meeting of the Pioneer Telephone Company, Limited, will be held at Winchester House (Hall 174), Old Broad-street, on Tuesday next, August 16th, for the purpose of considering, and, if thought fit, passing the following resolution—that is to say, "That the Company be wound up voluntarily." Should the above resolution be passed by the required majority, it will be submitted to a subsequent extraordinary general meeting for confirmation as a special resolution. The meeting will also be asked to pass a resolution fixing the amount to be paid to the Directors by way of remuneration for their services.

Liverpool Overhead Railway Company.—The Directors report that during the past half year fair progress has been made with the construction of the railway along the whole line of docks, and only 61 spans of the main structure are required to complete it, while the permanent way is laid as far as the viaduct is finished.

The electrical generating station is far advanced and the engines are in course of erection. The railway, it is expected, will be completed in October. After deducting interest on amount paid in advance of calls £60, and administration expenses £401, a balance is left to the credit of net revenue account of £720. The Directors have obtained an Act of Parliament providing inter alia for an extension of time for completing the railway, and authorising the construction of certain extensions at the north and south ends of the line.

Companies of the Month.—The following electrical companies have been registered during the past month:

Electrical Company, Limited, £5 shares	£15,000
J. C. Howell, Limited, £5 shares	25,000
Lithanode and General Electric Company, Limited, £1 shares	100,000
Railway Electric Reading Lamp Company, Limited, £5 shares	100,000
Richmond (Surrey) Electric Light and Power Company, Limited, £5 shares	50,000
Theatre Electrical and Specialities Production Company, Limited, £1 shares	5,000
Universal Arc Lamp Syndicate, Limited, £1 shares	3,000

Telephone Company of Ireland, Limited.—The report of the Directors of this Company for the year ended December 31st, 1891, states that a supplementary statement for the half year ended June 30th, 1892, is also presented, pursuant to clause 56 of the articles of association, which requires that the accounts shall be made up to a date not more than four months before the annual meeting. The Directors regret the delay that has occurred in the issue of the report, but the expiry of the two master patents in December, 1890, and July, 1891, rendered it desirable that all outstanding questions and accounts between this Company and the parent company should, so far as possible, be finally disposed of. Save as to a sum of £395 18s. 5d., the accounts between the two companies are now agreed to December 31, 1891, and are duly certified. All the telephone companies subsidiary to the parent company have now, with the exception of this Company, been absorbed by the National Company. In the event of an amalgamation being ultimately decided upon as preferable to a separate company for Ireland, the Directors will endeavour to effect it upon such terms as shall be just alike to this Company as to the National Company. Having regard to the probability of capital being immediately needed to meet developments, the Directors consider it prudent to keep a substantial cash balance available, and they do not, therefore, propose to pay the preference dividend, or any dividend on the ordinary shares at present, but the preference dividend being cumulative its payment is only postponed. The balance standing to the credit of the net revenue account, as upon December 31, 1891, including the balance brought from last account, amounts to £5,363, which the Directors propose to allocate as follows: To the credit of the reserve fund, £370 (being 10 per cent. of the net profits of the year), carrying forward the balance of £4,993 to credit of the current year. The balance to credit of net revenue on June 30 was sufficient not only to pay the whole of the preference dividend, but leave a substantial sum for division amongst the ordinary shareholders.

PROVISIONAL PATENTS, 1892.

AUGUST 2.

13932. **Improvements in telephone switchboards.** John William Yates and Harry Thornton Yates, 16, Commercial street, Sheffield.

13989. **Improvements in telephones.** John W. Gibboney and Elihu Thomson, 45, Southampton buildings, Chancery lane, London. (Complete specification.)

13996. **Improvements in electrical generators.** William Henry, 45, Southampton buildings, Chancery lane, London. (Complete specification.)

AUGUST 3.

14035. **An improvement in electric incandescent lamps.** Josef Pinter, 52, Chancery lane, London. (Complete specification.)

[illegible]. **An improved process and apparatus for the purification of sewage, and the production of alkalies, chlorine, ferric chloride and electric energy.** Walter Walker, 132, Adelaide road, London.

14043. **Improvements in arc lamps.** Walter John Hubert Jones, 6, Lord street, Liverpool.

14044. **Electrodes for secondary batteries.** John Corry Fell, 1, Queen Victoria street, London. (William Morrison, United States.) (Complete specification.)

14056. **Improvements relating to electric motors.** Henry Harris Lake, 45, Southampton buildings, Chancery lane, London. (William Stanley, jun., and John Forest Kelly, United States.) (Complete specification.)

14060. **Improvements in dynamo electric and electro-dynamic machines.** Alphonse Isidore Gravier, 191, Fleet street, London.

AUGUST 4.

14064. **A continuous direct electric current machine and motor.** William Aldred, 5, Brightside bank, Brightside, Sheffield.

14089. **Improvements in dry batteries.** Carl Christian Losenberg and John von der Poppenberg, 4, Moorfields, Fore street, London. (Complete specification.)

14096. **Improvements in automatic electric arc lamps.** George Henry Church, 21, Cockspur street, London.

14102. **Improvements in or connected with electrically applying railway brakes.** William Phillips Thompson, 6, Lord street, Liverpool. (Otto Berndt, Germany.) (Complete specification.)

14124. **Electrical machinery and apparatus for excavating and removing coal or other minerals, partly applicable to other purposes.** Frederick Hurd, 23, Southampton buildings, Chancery lane, London.

AUGUST 5.

14160. **Electric apparatus for working the elevating and training gear of guns and the lifts for their ammunition.** George Sylvester Grimston, 28, Southampton buildings, Chancery lane, London.

14180. **Improvements in or connected with electric batteries.** John Laskey Dobell, 57, Chancery lane, London.

14181. **Improvements in or connected with electric batteries.** Charles Percy Shrewsbury and John Laskey Dobell, 57, Chancery lane, London.

14189. **An improved method of and apparatus for distributing alternating electric currents.** Henry Harris Lake, 45, Southampton buildings, Chancery lane, London. (William Stanley, junior, and John Forrest Kelly, United States.) (Complete specification.)

14193. **Improvements in or relating to electrically controlled valves.** Adolf Franke, 46, Lincoln's inn fields, London.

AUGUST 6.

14199. **A new and improved form of electric testing instrument.** Arthur Albert Day, 80, Queen Victoria street, London.

14206. **Improvements in or connected with electric batteries.** John Laskey Dobell, 57, Chancery lane, London.

14217. **Automatic electric heat alarm.** Fred Sumner Palmer and Leonard H. Deasle, 70, Wellington street, Glasgow. (Date applied for under Patents Acts, 1883 sec. 103, 9th January, 1892, being date of application in United States.) (Complete specification.)

14229. **Improvements in incandescent electric lampholders.** Herbert Stone, 55, Market street, Manchester.

14239. **Improvements in electricity meters.** George Hookham, 7, New Bartholomew street, Birmingham.

14250. **Improvements in secondary batteries.** Sigmund Adolf Rosenthal and Villeroy Comey Doubleday, 77, Chancery lane, London.

SPECIFICATIONS PUBLISHED.

1891.

12019. **Carbons for electric arc lamps.** Wise. (The Rheinische Fabrik für Elektrische Bogenlichtkohle; W. Gradelbach.)

12150. **Magneto electric time-pieces.** May.

13362. **Dynamo-electric machines.** Forbes.

15407. **Galvanic batteries.** Cohen.

15579. **Electric switch and cut out.** March.

17697. **Electric telephonic transmitters.** Graham.

1892.

6007. **Cells for electrolysing chloride solutions.** Parker and Robinson.

10367. **Connections and terminals for electric wires, etc.** Sanelle.

10762. **Electric lamps.** Weaver and Manypenny.

11032. **Insulating supports for electrical conductors.** Harris.

11119. **Electric switches.** Broadway.

11147. **Secondary batteries.** Lloyd.

11154. **Welding metals electrically.** Thompson. (Coffin.)

11316. **Electric alarums.** Van Vianen.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	Price Wednesday
Brush Co.	—	3
— Pref.	—	2¼
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
House to House	5	[illegible]
Metropolitan Electric Supply	—	[illegible]
London Electric Supply	5	[illegible]
Swan United	3¾	3¼
St. James'	—	[illegible]
National Telephone	5	[illegible]
Electric Construction	10	[illegible]
Westminster Electric	—	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	3½

NOTES.

Paris Storage Cars.—We understand that the recent trials with accumulator cars in Paris have been very successful.

Berlin Exhibition.—The proposal to hold an international exhibition in Berlin in the year 1900 has been abandoned.

Walsall.—The poles for the electric tramcars at Walsall will be lighted by electricity and will have small refuges round the bases.

Turin.—It is proposed to utilise 5,000 h.p. in Turin by means of multiphase currents electrically transmitted from the waterfalls, 35 miles distant.

Dublin.—Additional tests have been made at Dublin, and great admiration has been expressed by the promenaders in the streets at the beauty of the electric light.

Dundee.—The Dundee Gas Commission have appointed Mr. W. H. Brownlee, of Dundee, to the position of electrical engineer to the municipal central electric station.

Brownhills.—The streets of Brownhills, near Walsall, are not yet lighted at all, and the inhabitants desire to have light. The question is to be discussed at next meeting.

Cable Rates.—The cable tariff to Australia has been increased by 9d. a word from October 1 next, the Press rates remaining as before. The rate to New Zealand is reduced to 5s. 3d. per word.

Dulwich.—More area to light is wanted by the Crystal Palace District Electric Supply Company, and the Camberwell Vestry have consented to an extension including a certain small area in Dulwich.

Chatham.—The Chatham Town Council have appointed a committee to consider and report upon the desirability or otherwise of acquiring by purchase the Chatham Electric Lighting Company's interests and works.

Electric Cable Railways.—The full text of the report of the Commission on Electric and Cable Railways (Metropolis) has just been issued by Messrs. Eyre and Spottiswoode, price 1s. 5½d., in the shape of a Blue-book.

Bath.—The inspector at Bath is to report fortnightly on the state of the public electric lamps. He is to have a testing apparatus for meters also erected on his premises at a cost of £40—the fixed fees for testing to go to the inspector.

Colchester. — The Colchester Town Council have unanimously decided, on the advice of their Electric Lighting Committee, to take the necessary proceedings for obtaining electric lighting powers for carrying out their own central station.

Fishing by Telegraph.—A timely telegram this season from the offices of the Scottish Fishery Board brought the boats to the right spot in Orkney, and a catch worth £3,240 was made. But for the telegraph this would have been impossible.

Kingston.—A proposal is to be placed before the Corporation of Kingston-on-Thames and the Surbiton Commissioners for supplying their districts with the electric light, generated by means of water power at one of the weirs upon the river.

South Shields.—The new police buildings, including two courts, now being built at South Shields are to be lighted by electricity. The County Borough Council have placed the contract, which provides for upwards of 200 lamps, in the hands of Mr. T. Harding Churton, of 5, South-parade, Leeds.

Maidstone.—At the next meeting of the Maidstone Local Board the members will be asked to appoint temporarily an electrical engineer to superintend the installation of the electric light. A lighting station will probably be erected in the Fair Meadow, at an expenditure of from £10,000 to £12,000.

Fleetwood.—The Fleetwood Improvement Commissioners have been granted an extension of time for their provisional order for three months. Fleetwood has been nibbling at the question for a long time. It is an improving and progressive town, and we hope that the project for electric light will be carried out.

Mannheim.—If anyone wishes to compete with German manufacturers on their own ground, there is a chance at Mannheim, where the central station is to be illuminated, and tenders are asked by the end of October. The specification (in German) can be obtained for 4s., from the Direction, Staats-Eisenbahnen, Karlsruhe.

Coast Communication.—At the last meeting of the Leith Chamber of Commerce a letter was read from Mr. Sandford Fleming, London, a delegate of the Board of Trade of Ottawa, regarding a proposed enquiry and report on the best means of promoting direct telegraphic communication throughout the British Empire.

Trowbridge.—At Trowbridge, where the Sanitary Authority wish to keep the powers in their hand, Mr. Chapman has recently explained that they did not wish to adopt a dog-in-the-manger policy. If a company made proposals they were willing to consider them. Mr. Haden said he had suggested premises at Cradle Bridge as suitable, but the question is left to the inhabitants to decide.

An Electric Canoe.—An electric canoe has been constructed by Messrs. Woodhouse and Rawson, who have named it the "Flash." The canoe is 18ft. long by 3ft. 9in. beam, with a draught of about 1ft., and will carry four persons. She is built of mahogany, and is fitted with a ½-h.p. motor, energised by Epstein accumulators. At the trial which took place recently, the "Flash" attained a mean speed of over six miles an hour.

Steam Yacht.—The magnificent yacht "Roxana," belonging to Mr. Singer, is now at Tenby. The "Roxana" is the largest yacht in the United Kingdom. She was formerly owned by the Prince of Luxembourg, and is lighted throughout by electricity. At present she is anchored close to the Castle-hill, and is a beautiful specimen of marine architecture. The projector light has caused much interest in the town.

Alicante.—An interesting installation has just been started at Alicante, in Spain, by Messrs. Siemens and Halske, of Berlin. Three Otto gas engines, made by Deutz, of Cologne, driven by Dowson gas, are used to run the dynamos, which are of the usual Siemens continuous-current type. This is the first central station, as far as we are aware, which is run by Dowson gas. The station is only small, but is none the less important.

Blue Electricity.—Some time ago a certain Count Mattei, of Italy, brought out a system of cure-all by means of phials of "red and blue electricities." He managed to get a large amount of approval, and to impose on a number of earnest men, but a strict investigation by a medical committee showed the result, as expected, to be a complete failure. It would be a very good thing if a little of the same kind of publicity could be given to the electropathic belts.

Arcing on Switchboards.—A jet of live steam is the latest addition to switchboard apparatus. In countries where the danger of a burn-out from lightning is serious,

the lightning arrester is a useful, and indeed necessary adjunct, but the flash sometimes causes an arc to be formed by the dynamo current following the discharge. To turn on live steam is found the best way to put out the arc. The use of a zinc alloy, as recently suggested, for the contacts would, however, probably be more practical.

Leith.—The new co-operative flour mills at Leith, when completed, will be capable of an output of about 4,000 sacks of flour per week, and the warehouse will hold about 40,000 sacks of flour. The machinery, which is to be of the newest description, is to be provided by Mr. Simon, Manchester. The buildings will be lighted throughout by the electric light. Last Saturday afternoon about 15,000 persons assembled at Leith Links and took part in a procession in honour of the laying of the memorial-stone.

Hysteresis.—An abstract in the *Journal* of the Institution mentions some interesting experiments by W. Kunz on the effect of temperature on hysteresis. With equal maximum induction the hysteresis loss distinctly diminishes with increase of temperature. In a piece of soft iron the loss per cubic centimetre was 23,190 ergs when cold, 19,180 ergs at 530deg. C. (dull red), and 21,640 when cold again. Steel showed a diminution of hysteresis of about 20 per cent. when raised to 100deg. The methods of measurement are not given.

The "Unique" Switch.—We note that Mr. A. P. Lundberg is now prepared to grant licenses for the manufacture, on royalty, of his latest patent switches—the "Unique"—both in England and most of the principal foreign countries, and we understand the terms are very favourable to responsible firms. We are pleased to learn that the "Unique" switches are rapidly coming into favour, and have already been taken up by two firms on royalty. In cases where we have seen them used they have given much satisfaction.

Berlin Electric Railway.—The proposal for the electric underground railway in Berlin is making progress. The line is to be equipped by the Allgemeine Company, and will be 30 miles long. There will be two generating stations connected together by mains, and using 500 volts. There will be 48 trains, each with three carriages, running at one time, the fare for any distance being 10 pfennig (1¼d.). The trains will run on a three minutes' service. The success of the London line is responsible for the proposed introduction of the system into Berlin.

Mansion Lighting.—Newbold Revel, the country seat of Mr. H. E. Wood, is to be electrically lighted with about 500 incandescent lamps, distributed between the house, stables, swimming-bath, gymnasium, and racket court. The installation is being arranged by Mr. A. A. C. Swinton, and the plant, which will comprise two Cornish boilers, two Parsons steam turbines and dynamos, and a large battery of "D. P." accumulators, will be similar to that recently completed by Mr. Swinton for Lord Durham at Lambton Castle, and to that at present being laid down by him for Mr. Clayton, M.P., at Chester.

Coatbridge.—Edinburgh waits, but Coatbridge, if not following Glasgow and Aberdeen (who have their own installations), at least expects the electric light before long. The master of works has reported that the Scottish House-to-House Electric Lighting Company had taken off a feu on the Dundyvan Estate for the purpose of erecting works for supplying electric lighting in the burgh. An application was made by the company for permission to open the streets for the purpose of laying the main wires, but the Council decided to ask for a plan of the streets they wished to open up before further considering the matter.

Coventry.—A quarterly meeting of the Coventry City Council was held on Tuesday, the mayor (Mr. Singer) presiding. A report from the Electric Lighting Committee, adjourned from February, was brought up for further consideration, accompanied by letters from Mr. A. Bromley Holmes, electrical engineer, Liverpool. The ex-mayor (Alderman C. J. Hill) moved that it be referred back to the committee, with instructions to take Mr. Holmes's letters into consideration, and recommend to the Council any scheme for the electric lighting of Coventry. Dr. Fowler seconded the motion, which was adopted.

Waterford.—The electric lighting scheme for Waterford is lost, and the gas company gain the day. The gas company sent in an offer to light the city with lamps consuming six cubic feet per hour at £2. 17s. 6d. per lamp for a period of five years. Further, they undertake not to apply for a provisional order for electric light except in case some other company so doing, when it might be worth while to protect their powers. The electric light company's offer was £22 per arc lamp a year, the same as before. After an uproarious meeting the resolution was carried, by twelve to six, that the gas company's offer be accepted as final.

National Physical Laboratories.—*Ever since Prof.* Oliver Lodge mooted the subject at the British Association last year, the proposal for the establishment of a national physical laboratory has been looming before us. Dr. Arthur G. Webster, in an article reproduced in the *Electrical World* of August 6, takes up the matter from the American standpoint, and urges the need for such an institution in that country. His proposals will be read with interest by those who are pressing the question forward. A considerable part of the article consists in an account of the German Reichsanstalt established under the superintendence of the veteran *savant*, Prof. Hermann von Helmholtz.

Testing Instruments.—Apparatus for testing and for experiment is likely to be more and more in demand both for installation work and private use, now that electricity is studied as a "subject" in all good schools. Mr. R. W. Paul, of Hatton garden, is making quite a name for himself in the department indicated. He has read several good papers before the Physical Society, has produced several ingenious instruments of his own, and makes those of Prof. Ayrton and others. Mr. Paul's instruments may become well known, and to help this result he has issued recently a neatly-printed catalogue embodying many good types. The special set of apparatus for Prof. Ayrton's "Practical Electricity" is a good idea and worth attention by technical schools.

Yarmouth.—The Yarmouth Town Council have decided to ask Mr. Preece to report upon the tenders they have received for a central electric installation. These tenders, from six different firms, have been opened, and vary from between £5,000 and £6,000 up to £[illegible]. This variation is no doubt due to the fact that no actual specification was issued, but each firm was left to suggest and send in their own plans. The smaller schemes embody a small plant at low cost, while the larger schemes embody a full project for lighting. The surveyor will get out an analysis of the tenders, and Mr. Preece's advice will be taken, as we have said, upon the general bearings of the scheme. The thorough way in which this was done at Worcester will lead the Yarmouth Council to feel themselves in very safe hands.

Installation Efficiency.—Careful experiments have been carried out with the electric plant at the Argenteuil railway station by the French Edison Company. The boilers are two of Weyher and Richemond's, engines are

speed (85 revolutions), 35 h.p. to 50 h.p., by same makers, driving Edison dynamos, 115 volts and 240 amperes at 950 revolutions. The lamps comprise 30 arcs of 6 to 12 amperes, and 95 incandescents of 10 c.p. and 16 c.p. The two extreme arcs are three-quarters mile apart. The test with all lamps and an added resistance gave a total of 26,400 watts absorbed. The output was 460 watt-hours per kilogramme of coal, or 209 watt-hours per pound, equal practically to 5lb. of coal per supply unit. This was 30 per cent. better than specification, and is a result that may be regarded as very satisfactory.

Collier-Marr Telephone.—We drew attention some time ago to the Collier audible telephone, which apparently promised to be an improvement over ordinary forms. This telephone has been improved, and is now being manufactured, works having been fitted up with suitable plant and machinery. A company has recently been formed, with a capital of £100,000, with offices at the works, Derby-street, Oxford-road, Manchester, to carry out the patents. Orders have already been received from the General Post Office, the Canadian and Indian Telegraph Departments, the Great Northern Railway, the General Electric Company, and the Corporation of Bradford, and important negotiations for the supply of instruments have been opened with other English railway companies. These orders and negotiations are the results of successful trials of the instruments.

Fire-Alarm Box.—What shall be the solution to the "false alarm" problem of the Metropolitan Fire Brigade? We can hardly think that the man in the street who sees a fire will enter a chamber like unto the torture-maiden and consent to be left locked in until the policeman or fireman come to his rescue and let him out. Nevertheless, such is the bold and ingenious idea embodied in the combination street alarm station now on view at the Fireman's Exhibition. No signal can be given until the door is shut, and then it is locked upon the alarmist, whose only consolation is that he can telephone at his ease to all the fire stations in London. What a fate if the fire were to spread and roast him alive in the alarm station! We prefer the French method of telephones in a box. Persons giving false alarms will ring a bell, but would hardly be so likely to send a deliberate telephone message.

Electric Light in Italy.—Now that Rome is about to utilise the cascades of Tivoli for the purpose of obtaining the electric light, it is surely time, remarks the *Daily Graphic*, that the great cities of England were bestirring themselves if they do not wish to be left altogether behind in the race to secure the advantages of electricity. The Englishman who enters Italy with the fixed persuasion that his own country must necessarily be far ahead of Italy, as regards electric lighting, is astonished, if he enters Italy by the Riviera, to find that Genoa has its streets almost wholly lighted by electricity. He moves on to Florence, and if he is set down by night at the railway station he sees no gas lamps anywhere as he drives to his hotel—only the electric light. He visits Venice, and there he finds the Square of St. Mark's lighted by electricity in a way in which no public space in London is lighted. Even at Rome itself the electric light is already in the streets in the neighbourhood of the railway station. We may do it better than they in Italy, perhaps, when we really set about it, but we cannot now be first.

Coast Communication.—The Royal Commission to enquire into the means of communication between lightships and the shore have visited Liverpool this week on a tour of inspection. The Commissioners, accompanied by the chairman of the Mersey Harbour Board, the marine surveyor, and other port officials, made a trip down the Channel inspecting the Crosby, Formby, and north-west lightships, with a view of ascertaining the best and most effective means of establishing a system of communication between these vessels and the lifeboat stations ashore, in order to secure the readiest assistance for vessels in danger and to promote the saving of life. The Commissioners will inspect the lighthouses off Liverpool, and thence proceed to Kingstown *viâ* Holyhead, to hold a conference with the Irish Light Commissioners. After visiting the light stations on the east coast of Ireland they will go to Milford Haven, and visit the lighthouses on the South Wales coast and the south side of the Bristol Channel, voyaging thence round the Scilly Isles, along the south coast of England to the Thames, and northwards to Edinburgh, to hold a conference with the Northern Lighthouses Commissioners.

Barnsley.—We trust the Electric Lighting Committee at Barnsley will not cease their endeavours to introduce the electric light, in spite of their recent rebuff, which is for the second time. The committee—who consist of the mayor (Alderman Blackburn), Alderman Wray, Councillors Haigh, Jackson, and Wheelhouse—have considered carefully their report, and recommended the adoption of a central electric station for the town, with Mr. Bromley Holmes as engineer, but their recommendation was rejected. Mr. Raley is already converted, but thinks the best way would be to leave the lighting to a private company, in spite of Bradford and St. Pancras. Dr. Halton was the principal opponent to the scheme, on the score of expense. The first scheme was to cost £24,000, and this one £18,000, which he still regarded as too much; though his principal objection apparently was the cost of the lamps—3s. 6d.—which he had seen would soon be a shilling each only. The worthy doctor did not seem to realise that this saving would not affect the present question of plant at all, though it would reduce the future charge for lamps. The councillors who want converting are Aldermen Bailey, Woodcock, Marsden, and Pigott; Councillors Taylor, Sykes, Webster, Hinchliffe, Fountain, Halton, Frith, Holden, Bailey, Tyas, Tinker, and England. Electrical engineers have a twelvemonth to accomplish their conversion.

Windsor.—The electric lighting question at Windsor is in a little bit of a fix. The Town Council some years ago spent £80 in considering the matter, and decided to support the application of the Windsor Electric Lighting Company, but this company has somehow or the other not succeeded in obtaining all the capital they require. (Why is there not some means of obtaining a little more capital, if the project is in businesslike form?) The company now want to give up part of their powers and light two streets only. The following is the report of the Electric Lighting Committee presented at the last meeting by Mr. Dyson, the chairman: "Your committee recommend the Town Council to reply to the letter of the Board of Trade that the Council have no objection to the company laying down their distributing mains in the two streets named in the application of the company, provided that the Board of Trade are satisfied that the company have sufficient capital and means to carry out the same, and to provide for the continuance of the supply of electricity for a reasonable period, and, further, that conditions be imposed compelling the company to lay down distributing mains and supply energy over the whole area of supply in a fixed time." Mr. Dyson asked to be excused from moving the report, as it was his opinion the lighting should remain in the hands of the town. Mr. Soundy then moved its adoption, saying the committee

wereunanimous except for the chairman. Mr. Burt explained they wished to throw the onus of seeing the thing well done on the Board of Trade, though the town clerk remarked they had power themselves to fine the company £5 a day for non-fulfilment of the order. Mr. Dyson said he was anxious to avoid another monopoly, and moved an amendment that the Council do not agree to the modification of the order already granted, but the motion to adopt the report was carried by nine votes to five.

Southport.—A special meeting of the Southport Town Council was held on Tuesday under the presidency of Councillor A. Pilling, deputy mayor, for the purpose of considering the recommendation of the Gas Committee with regard to the adoption of the electric lighting system by the Corporation. Estimates showing a proposed capital outlay on the scheme for £27,060 were submitted. This is to cover the cost of buildings and distribution mains sufficient for 6,600 16-c.p. incandescent lamps, or 12,000 lamps of 10 c.p., and for the generating plant for the supply of 1,900 16-c.p. incandescent lamps, or 3,700 lamps of 10 c.p. The committee recommended the adoption of these estimates, and that 8a. 1r. 18p. of land behind the gas works at Crowlands be purchased out of the capital moneys of the gas estate, of which land 3a. 1r. 18p. be used for the purposes of electric lighting, subject to the approval of the Local Government Board. Alderman Hacking, chairman of the Gas Committee, moved the adoption of the minutes containing these recommendations. He recounted the circumstances which had led to the Corporation to decide upon becoming the electric lighting authority of the town, and to undertake the work itself instead of letting it to contractors. He also explained that the Council had already resolved to adopt the high-tension system, and to place the installation on a site adjoining the gas works at Crowlands. The scheme they now recommended embraced two services, one for the supply of electricity to the residential district having Hesketh Park as its centre, and the other to the business section of the town. The energy generated by the plant at the Crowlands station would be distributed at 2,000 volts, but this would be reduced at the transforming stations to 100 volts. Councillor Travis seconded the motion, and other members having spoken in general commendation of the scheme, the minutes embodying the committee's recommendations were unanimously agreed to.

Prescot.—The electric lighting question is occupying the minds of the people of Prescot very fully at the present moment. The British Insulated Wire Company, of that town (of which Mr. C. H. Yeaman is engineer), has made an offer to provide an installation and light the town by electricity. Their first estimate not being considered acceptable, the company have now made a second amended and fuller offer. Prescot, they said, was favourably situated for a central station, and they offer to provide a mixed installation of 12 arc lamps of 2,000 c.p. and 70 incandescent lamps of 12 c.p. actual each for the sum of £350 a year for a five years' contract. The arcs would be kept alight till midnight, 50 of the incandescents until the usual hour, and the other 20 until the daylight came on the scene. They also asked for 4½ per cent. on £400 for lamps and fittings. The Board held a long sitting to discuss this offer, and both cost of running and the candle-power of the lamps came in for explanation. Mr. Yeaman was in attendance, and explained that £350 a year would cover everything for five years, but had no reference to the item of 4½ per cent. on the outlay for lamps and fittings. If the contract were not renewed at the end of the five years, the company could not consider their plant sufficiently deteriorated as to be valueless in itself, though it would then be practically valueless to them, and a five years' contract would thus not recoup them for their expenditure. In consideration of this fact they asked 4½ per cent. on the £400 at the end of the term if the contract then came to an end, but the item would not be charged at all if the Board and the company were still satisfied with each other. The £350 would cover "everything incidental and necessary to the lighting of the town." There was another item of 4½ per cent. required elucidating, and Mr. Yeaman explained that in cases where the company was asked, for æsthetic or other reasons, to lay cables underground against their ordinary practice, they would ask the Board to pay interest on the cost of such an unusual outlay. Mr. Atherton, the managing director of the company, eventually consented to forego these items of 4½ per cent. The gas lighting at present costs £260 a year, plus a man at 18s. a week—£304 a year for gas—so that the increase will not be serious. Mr. Yeaman promised to have the light started in a month. An amendment to accept the gas company's tender found no seconder, and the resolution to give the contract to the Wire Company was passed. The authorities in St. Helens are understood to be watching the movements of Prescot.

The Brain Covered-Conduit System.—*Closed* conduit systems for electric traction are slowly *evolving* themselves, and a new one is now before *the engineering* and tramway world. We have seen Mr. Lineff's ingenious idea of the serpentine underground contact-maker in practice, and a British Association paper gave prominence to the scheme. We have heard little of it since—the telephone clauses, perhaps, were too hard. Mr. Wynn had his contact-boxes under every length, and his system is promised on a large scale shortly. Mr. Gordon, with the same idea reduced to a box every hundred yards, was taken up by Messrs. Merryweather, who, however, have not yet come to the stage of putting it down. The only conduit system at all a success as yet is that at Budapest, but that is an open slot conduit. Now, Mr. C. T. B. Brain, of Bee-buildings, South John street, Liverpool, brings forward an entirely different and most bold scheme, described in his pamphlet now before us, in which there is a combination of closed and open conduits. He has a small open conduit in which the conductor is laid, contact being made by a trolley wheel from the car. But the whole slot is covered in with a thick band of flexible metal, which effectually closes the slot and is capable of bearing the weight of many tons. The car in passing raises the flexible cover, making contact, of course, below, and lays the cover again lightly behind it, rolling it down by a projecting roller. Here is your solution—and an ingenious idea it is. Further, Mr. Brain appears to have tried his system thoroughly and practically during the past year—in rain, hail, and shine. Water and dirt cannot get in, and no one can raise the lid without extreme trouble. The ice cannot resist the shearing force of the rising cover, even in a hard frost. But most important of all, if it is necessary to inspect the conduit, all that is needed is to turn a screw on the car contact and send the car along and the whole cover is lifted and deposited on the roadway at the side. Repairs and inspection made, the car is run back and the cover settles into place. Really it seems an admirable idea, and if only practical in working we may have here the underground conduit problem solved. All kinds of turn-outs and switches have been, we are told, constructed and worked, and the system is stated to give every satisfaction on the experimental line. The cost of installing is small. All that is needed is to see it in action on some scale and

submitted to the tests of practical men. Mr. Brain claims his invention as the outcome of seven years' experience on Blackpool electric railway and elsewhere.

Varley Testimonial.—The committee who have the proposed Varley testimonial in hand have issued a statement, in which the life-long labours in electrical research of Mr. S. A. Varley are set forth. The following is a brief abstract. Born in 1832, he commenced the study of chemistry at the age of 14, and in 1849 experimented with hundreds of cells constructed with his own hand. In 1852 he entered the service of the Electric Telegraph Company, and was in 1854 appointed to the charge of telegraphs in Liverpool. He constructed an electric chronograph, and in the spring of 1855 took charge in the Crimea of the first field-telegraphs used in war. In 1858 he wrote "On the Electrical Qualifications requisite of Long Submarine Cables," and his opinions were endorsed by Faraday. In 1866 Mr. Varley discovered for himself the reaction or self-exciting principle of dynamos, and at that early date constructed his first machine of the pure dynamo type, now in South Kensington Museum. It was awarded a gold medal at the Inventions Exhibition. The controversy which subsequently arose on this invention may be held to have been fitly summed up by the late Robert Sabine, C.E. (son-in-law of Sir Chas. Wheatstone), in the following words: "Prof. Wheatstone says he was the first to complete and try the reaction machine. Mr. S. A. Varley was the first to put the machine officially on record in a provisional specification, dated December 24th, 1866, which was, however, not published until July, 1867. Dr. Werner Siemens was the first to call public attention to the machine in a paper read before the Berlin Academy on the 17th January, 1867" (see *Engineering*, November, 1877). In 1866 he introduced needle telegraph instruments with soft-iron induced magnetic needles, which have superseded the old form. In 1875 he became assistant manager at the works of the British Telegraph Manufactory, where the first Gramme machines constructed in England were made. There is scarcely a doubt that Mr. Varley's investigations at this period led to the invention of compound winding. Mr. Varley's *magnum opus* is the important part which he took in the invention and perfecting of the dynamo, perhaps the most striking invention of the century, and upon this his fame as a patient, conscientious, and earnest scientific investigator of the Faraday school will permanently rest. His researches were undertaken in the true spirit of science, and no thought of self-emolument has ever caused him to deviate from the path which he has pursued throughout an eventful, although eminently simple and blameless, life—a life in which self-denial and self-sacrifice have no small share. Like many men of genius, he was far ahead of the times and has lived to see others reap the benefit of his great discoveries. His nervous and retiring disposition has for years kept him from the busy haunts of men, and to the younger generation of electricians he exists only in name—a name, however, that will live as long as the dynamo is employed in the service of man. Subscriptions to the testimonial will be gladly received by the hon. treasurer, Mr. A. Stroh, 98, Haverstock-hill. Mr. R. E. Crompton is secretary, and the committee, commencing with the name of Lord Kelvin, includes nearly all the most prominent British electrical engineers of to-day.

Taunton.—At the quarterly meeting of the Taunton Town Council last week, the Electric Lighting Committee recommended that in case they purchase the electric company's undertaking the Council shall repay the cost of meters and transformers to customers. They also recommended that the company be asked to lay the mains for the proposed extension, the Council to pay the amount expended thereon. The Mayor moved the adoption of the report. He said it was quite understood that the transformers and meters—provided the negotiations were completed—would ultimately become the property of the Corporation, and in order to provide against any loss of time to persons wishing to take in the light, the Corporation should make the offer to take over the articles mentioned at cost price. The town clerk then read a letter from the electric light company, stating that the directors had passed a resolution to the effect that they would find the wire to supply the private lighting in the Staplegrove-road extension if the Council would excavate the trench and lay the public lighting wire. Mr. Meyler also read the following report which he had drawn up respecting the legal position of the Council on the matter: "I think it is advisable that the members of the Corporation should know how matters stand as regards their powers of treating with the Electric Lighting Committee for an extension of the lighting. The existing contract with the company provides that all posts and out-posts for lamps and wires be supplied by the Council, and it further states that all such alterations as may be required by the Council for their own convenience shall be made by and at the expense of the Council. At an interview with some of the directors of the company with the committee on the 30th May it was suggested that there should be an extension of the lighting, and that the Corporation should supply posts and lamps for such purpose; but at that time overhead wires were contemplated. On the 26th day of July, the Council resolved to extend the lighting by placing seven new lamps in the positions then mentioned. A question has arisen whether the Council have power to lay underground wires for the purpose of such lighting. I think they have. The contract provides that alterations (which includes such additions as these) shall be carried out at the expense of the Council. I understand that these wires cannot be utilised for private lighting, if, therefore the company wish to lay wires or mains for private lighting, the Corporation might fairly ask for a reduction in the charge per lamp for the new lamps, as the cost of the outlay connected therewith falls on them. The payments in respect of these new lamps must fall, in the first instance, on the general district rate. The Local Government Board may or may not include these payments in the loan, but I have never known them refuse to include amounts properly expended before the application has been made to them. It would have been better if all questions as to extensions could have been allowed to remain over until the purchase is completed, but if the majority of the Council think that there are circumstances which render it advisable to extend the existing lighting there is no legal difficulty in their doing so. I have received the draft contract from Messrs. Kite and Broomhead, and have, at their suggestion, agreed that it shall be settled between both parties by counsel, and we can, I have no doubt, agree upon some gentleman who is an expert in this special branch of the law." Alderman van Trump seconded the Mayor's motion. Alderman Spiller said the electrical firms in the town should have an opportunity of tendering for materials if it could be done. Councillor Sibley said that the cable proposed had been a great success at Exeter. The surveyor mentioned that the cost of the Staplegrove-road extension would be £69. 17s. 6d. for the cables and laying, and £141. 15s. altogether, with the lamps, poles, etc., complete. The report was then adopted, and the terms of the company respecting the laying of the new cables were accepted.

PRACTICAL INSTRUMENTS FOR THE MEASUREMENT OF ELECTRICITY.

BY J. T. NIBLETT AND J. T. EWEN, B.SC.

VII.

(*Continued from page 74.*)

RESISTANCE, *continued.*

Wheatstone's Bridge and Resistance Box Combined.—The original form of Wheatstone's Bridge with long base board and stretched wire was found much too cumbrous for ordinary practical use, and the stretched wire was also liable to get damaged. On these accounts, therefore, the use of the Metre Bridge is now chiefly confined to laboratory testing and for educational purposes, although the simplicity and exactness of this method of measuring resistances was too apparent to allow the principle to be discarded in the construction of commercial instruments.

Fig. 8 illustrates diagrammatically the application of the Wheatstone's Bridge principle to the numerous and varied forms of apparatus included under the general title of Post Office Wheatstone's Bridges, so called because the compactness and portability of the arrangement render this class of instrument particularly suitable for testing the resistances of overhead and submarine telegraph lines, which at the time when this type of apparatus was first introduced, was almost the only kind of electrical measurement made outside the walls of scientific laboratories.

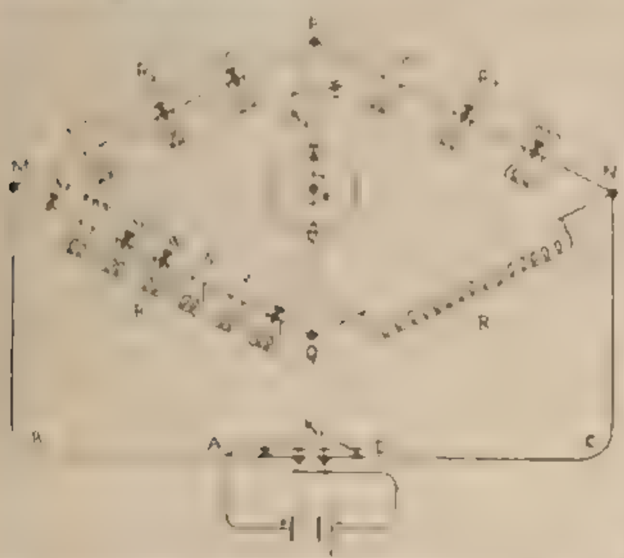


FIG. 8.—Theoretical Diagram of Post Office Wheatstone's Bridge.

In Fig. 8, the arms R_1 and R_2, which in the Metre Bridge were represented by the stretched wire and adjusted by the movement of the point P along it, here consist of two similar sets of fixed resistances. These usually comprise three coils each, as shown, of 10, 100, and 1,000 Ohms resistance respectively, although in some cases, where greater accuracy is desired, an additional 10,000 Ohm coil is added to each arm, and, again, in some of the less elaborate forms of the apparatus each arm has only two coils, one of 10 and another of 100 Ohms. With three coils in each of the arms P M and P N as represented in Fig. 8, and with a single plug removed from each, the ratio $\frac{R_1}{R_2}$ may be given any of the following values

$$100, 10, 1, \tfrac{1}{10} \text{ or } \tfrac{1}{100}$$

Other values may be given to this ratio by varying the number of plugs removed from each of the arms, but this is seldom done, owing to complications being thereby introduced into the readings. The arms P M and P N are usually known as the Ratios of the bridge.

R_3, the known variable resistance, which in the Metre Bridge was represented by a separate Resistance Box, is here incorporated in and forms the principal part of the combined apparatus itself. It is represented in the diagram, Fig. 8, in its most usual form, a set of plug resistance coils, of which, however, only a few are there shown. The combinations most commonly used are coils of :

1,	2,	3,	4,
10,	20,	30,	40,
100,	200,	300,	400,
1000,	2000,	3000,	4000 Ohms,

and to these is generally added an "Infinity" plug, which resembles all the others in outward appearance, but has no resistance coil attached underneath, so that it affords a convenient means of completely breaking the circuit altogether by simply removing the plug from its socket. The removal of any of the other plugs simply throws into the circuit an additional resistance equivalent to that of the coil bridging the gap from which the plug was removed, the current having now to pass through that coil and be retarded by its resistance, instead of simply passing through the plug, which offered practically no resistance whatever to it.

Another arrangement of the coils in R_3, somewhat similar to the one just given, is provided with the following resistances :

1,	2,	2,	5,
10,	20,	20,	50,
100,	200,	200,	500,
1000,	2000,	2000,	5000 Ohms,

with an "infinity" plug added as before. With either of the above arrangements, the maximum value which can be given to R_3, excluding the use of the "infinity" plug, is the sum of all these resistances, or 11,110 Ohms, and it may be made any exact number of Ohms less than this.

A third arrangement of resistances, although more economical in the matter of coils than either of the preceding ones, is little used owing to the difficulty of reading off the total resistance if it is at all high. In this case the coils are arranged so that their resistances increase in geometrical progression, each being the double of the one preceding it. The series usually starts with a pair of unit coils for convenience in testing, and ends with an "infinity" plug, as in the two former cases. Thus with a set of fourteen coils of 1, 1, 2, 4, 8, 16, 32, 64, and so on up to 4,096 Ohms arranged on this plan, the total resistance of R_3 may be made to take any value from 1 to 8,192 Ohms. The methods of constructing, adjusting, calibrating, and standardising these and other forms of fixed resistance coils will be considered later on.

It is sometimes desirable, in order to eliminate errors of instruments, etc., to have at hand a convenient means of reversing the current in the circuit, and a method of accomplishing this is shown diagrammatically at K_1 in Fig. 8. Here, if the right hand contact maker is depressed so as to touch the connection beneath it, the current flows from the positive pole of the battery, through the left hand contact maker, then past A and B to M, where it divides itself and flows through the arms of the bridge from M to N, then past C and D, and through the depressed right hand contact maker to the negative pole of the battery. If now the right hand contact maker is released and allowed to return to the position shown in the diagram, and the left hand one is depressed in its stead so as to touch in its turn the connection beneath it, the current from the positive pole of the battery will now flow through the right hand contact maker, past D and C to N, through the arms of the bridge from N to M (which is the reverse direction to the former case), then past B and A, and through the depressed left hand contact maker to the negative pole of the battery, thus again completing the circuit. This principle is embodied more or less in nearly every variety of reversing key. In the next paragraph are given a few examples of the numerous reversing and other keys and contact makers now in use for the testing of resistances and other similar purposes.

Keys and Contact Makers.—As a means of establishing contact between two pieces of wire so as to complete an electrical circuit the obviously easiest method, that of simply holding the two ends together so as to keep them in contact, is extremely inconvenient and unreliable, and a large number of keys and contact makers have been devised for this purpose. The forms of these vary with the special requirements for which they are constructed, and range from the simple contact maker, Fig. 9, with flat brass spring which establishes contact by being depressed on to a stud and breaks the circuit again on being released, to the somewhat complicated

conditions demanded by the very heavy suburban traffic of the metropolis. It has, however, been in a certain measure successful, as indicating the possibilities of electric traction on railways, and the economy to be effected by the use of iron tubular tunnels following the lines of streets at a sufficient depth below the surface to avoid sewers and pipes and disturbances to property. The result is that several Bills have been promoted during the last session of Parliament for the construction of similar lines in various directions. One of the most important of these is the proposed Great Northern and City Railway from a point near Finsbury Park Station on the Great Northern Railway to Finsbury Circus. It differs from the others in that it is intended to run the ordinary passenger trains from the main line of the Great Northern Railway to the heart of the City without change of carriage. To do this it is obvious that electric engines of much greater power are required than those at present in use on the City and South London Railway. It is claimed for this engine that it would fulfil all the conditions which this line demands, whilst, if made on a smaller scale, it would be more economical for working the traffic of the other lines referred to than those at present in use.

It is proposed to work on a central rail similar to that used in the Fell system, and to arrange the electric motors vertically, so that the driving wheels may be horizontal. The necessary adhesion is to be obtained by means of springs, which press the driving wheels against each side of the central rail. One great advantage afforded by this arrangement is that it enables the electric motors to be kept constantly running, even when the engine is stationary, thus avoiding the great loss of power incidental to the starting of the engines now in use. A friction wheel is interposed between each electric motor and its corresponding driving wheel in such manner that they can all be thrown in and out of gear at the pleasure of the driver. The electric motors, which are the most delicate part of the machine, are carried on a platform supported by the springs, and consequently are not subject to the shocks caused by inequalities of the road. Another advantage of this type of engine is that it can be constructed of any reasonable size, and may, therefore, be far in excess of the power of the largest steam locomotive, which is limited by the size of the boiler. The dead-weight also of this engine would be considerably less in proportion to that of the steam locomotive, as the tractive force is obtained by gripping the central rail and not by gravity. It is especially applicable to lines where the gradients are steep.

In all central rail systems a difficulty at once arises as to points and crossings. This has been overcome by a novel form of switch, which is illustrated by a working model. It is the patented invention of Messrs. Purdon and others. The description is as follows: The pieces of rail of similar section to that used for the central rail are curved to a suitable form, and coupled together by a special casting near each end; the two sections of rails are not in the same longitudinal plane, and each cross-piece is provided with a roller working upon a horizontal axis. At the centre of the length of the two portions of rail a casting is fixed, which is common to both, and is so formed that it rides freely upon a vertical pivot which is fixed to a sleeper or other suitable part of the permanent way. The two sections of rail which thus form a kind of rocking cradle are free to move upon the centre pivot, and the rollers at each end travel upon paths of a segmental form when looked at in the plan. In elevation the segmental paths are so formed that one section of the rail can be moved into position with, let us say, the main line track, but, when the rocking cradle is swung sideways the second rail, which, as previously described, is in different plane, is caused to rise during its swing, and complete the middle rail for the branch, or cross-over line. It must be understood that owing to the different level of the two sections, the portion which is not in use at any given time lies below the horizontal plane passing through the top of that which is in use.

The engine is provided with ordinary flanged wheels, as it is designed to meet the case of a railway where it is desired to haul ordinary stock, and where the curves are not sharp; but in the case of lines like the City and South London Railway before referred to, where the grades are steep and the curves very sharp, the carrying wheels need have no flanges, and the stock can be made to take very sharp curves—indeed, up to 50ft. radius without difficulty. This advantage of the central rail system, which is illustrated by the model truck exhibited, becomes very important in cases where it is desired to pass under streets which diverge at right angles, and also at termini, where a balloon-ended station will do away with the necessity for shunting operations or breaking of electrical connections.

THE DESTRUCTION OF LIGHTNING PROTECTORS BY RECENT MUNICIPAL LEGISLATION.*

BY W. H. PREECE, F.R.S.

The immunity of private houses from being struck by lightning is very marked, and this is considered to be due to the fact that the lead on our roofs, and the iron stack pipes that drain these roofs, connected as they are together, form admirable lightning protectors. Any charge of atmospheric electricity which may fall upon a house so protected is conveyed harmlessly away to the earth. Householders are now required to remove these pipes from direct connection with the drains, and to leave an air space between the end of the pipe and the grating of the drain. The result is that the electric conduction of the pipe is broken, the stack pipe ceases to be a lightning protector, and houses are left exposed to the dangers of atmospheric electricity.

The remedy is very simple. The pipe need not be entirely cut away: three-fourths of its circular section may be removed for the distance required; and one-fourth may be left to maintain the old electrical connection, or if the separation has been effected, then the stack pipe should be connected with the drain by a wire or rod so as to restore a path for the charge to the earth.

Householders are also now compelled to put up stack pipes to ventilate their soil-pipes, erecting above their roofs a metal tube forming a prominent object, exposed to the atmospheric charge, and terminating frequently in an earthenware pipe on the first floor. They are thus liable to be struck by lightning without offering any means of escape. They should be connected electrically with the earth either directly or indirectly through the stack pipes, which would then make them sources of safety rather than of danger.

SUBMARINE RELAYS.

The following note from the *Moniteur Industriel* seems sufficiently important:

M. Willot, inspector of telegraphs, has returned to Paris after two months in Algiers, which he has spent in experimenting on the submarine cables between Marseilles and Algiers. These experiments were carried out with the object of increasing the capacity of transmission and of rendering the service easier by means of apparatus analogous to that used in overhead wires. The experiments have given unhoped-for results. By means of a new system of relays invented by M. Willot, communication can now be maintained direct between Algiers and Paris, with Hughes and Wheatstone instruments, as easily as with overhead wires of the same length. The telegrams are received on a printed strip as on ordinary lines, and are not subject to the transformation now obligatory on submarine lines employing the mirror galvanometer. The tests carried out by M. Willot leave us no doubt as to the final success, and Algiers will, therefore, be shortly connected direct to Paris. Telegrams, instead of taking at the minimum 3½ hours and often three or four hours in sending, will now be transmitted in half an hour at most.

Electric Terms.—The second edition of Prof. Houston's "Dictionary of Electrical Terms" is meeting with much success.

* Paper read before the British Association at Edinburgh.

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STORAGE TRACTION FINANCE.

Determined efforts are being made, we are glad to hear, to put the accumulator traction problem on a thoroughly sound basis. We trust these efforts will not miss their aim for want of a little knowledge and enterprise. We can look back to the time when the "box of energy" came over from France and was tested by Lord Kelvin (then Sir William Thomson), the results of whose research resounded through the length and breadth of the world. If we have not yet achieved all that was expected by journalists from this discovery by Faure of the pasted cell—if boxes of energy are not as yet delivered around like milk to the door—we are getting near to this consummation, as witness the railway reading lamps recently mentioned, which are to be distributed in thousands all over the metropolis. In central station work no one can complain, in England at least, that the storage battery has not done good, honest service, creditable alike to the manufacturer and the electrical engineer. The storage battery for lighting has been a success. But how is it with the storage battery used for traction? Where are our large and well-filled cars in every great town driven by electricity? They are yet to come—and the difficulty, hitherto one of electrical engineering, is now one of finance. "Will it pay to run storage cars?" The answer, "Yes," is being pronounced with a more and more confident ring, and this notwithstanding the costliness of certain well-known experiments. The time for experiments is done. Away with them, and let us have good, large, straightforward contracts, in which each party is willing to take their share of the responsibility, and to guarantee the performance of their share of the work. The parties are willing. "Is there any just cause or impediment" to stand between the fulfilment of their wishes? is the question to be asked.

The history of storage traction in this country is bound up to a large extent with that of the pioneer line of five cars at Barking-road, and though there is no reason to give too much importance to this small and out-of-the-way line, yet the results there achieved necessarily have a direct bearing on the future employment of storage cars elsewhere. The contract between the General Electric Traction Company and the North Metropolitan Tramway Company at first was to run the cars and supply power and driver for the sum of 4½d. per car mile run. This contract ran for three years and, not paying, was eventually raised to 5½d. per car mile, at which rate the contract ran for one year. The question was lately raised whether the North Metropolitan Company would take over the installation, and, being a large company, instal a greater number of cars, which might then be run on a paying basis. This they did not see their way to do, nor yet to increase the number of cars. The offer of the traction company to run in the future these five cars only for 2d. a mile extra was refused by the tramway company, as it would make an addition of nearly £1,600 a year to the cost of running the line, and, notwithstanding the rise in the price of fodder, would exceed the cost of horse traction.

but they eventually agreed to pay another 1d., making 6½d. per car mile, and they also agreed to put the line in thorough order. The loss (if any) was, by a business arrangement, to be divided between the traction company and the storage battery company, who were equally interested in its success. For some little time the service had not been so good as it might have been owing to stoppages, due, it is said, to defects in the permanent way. These defects tried the axles—which themselves were not as strong as they should be—and when a breakdown did occur, it was not only on the car axle, but this breakage spoilt the motor armature. It is significant that both permanent way and axles were just that part of the line supplied by the tramway company and remaining under their control. After many requests the road was at last repaired, and since then all has gone well. Nevertheless, after preliminary *pourparlers*, after the permanent way was restored and the new agreement made ready, suddenly the tramway company, either being tired of the trouble or losing interest in the experiment, announced their intention to terminate the contract on September 1st. The directors of the traction company would not undertake to do anything further unless the contract was renewed for twelve months, and therefore withdrew the cars. This is how the matter now stands, and from the electric traction point of view several morals can be drawn. First, that it does not pay to run five cars only by electricity; secondly, it is not wise to run cars the axles and wheels of which (designed for horse cars) are supplied by the tramway company; and, thirdly, that a stringent clause must be inserted as to the thorough repair of permanent track when the traction is undertaken by a separate company on contract. These morals are plain and on the surface. The fourth moral, with reference to the cost of electric traction, is not so plain, and we will now proceed to draw it to the best of our ability for ourselves, our readers, and the tramway companies at large.

It seems that the companies are unwilling and unable to run the tramcars themselves by electric traction. Therefore, either the storage manufacturers must take up the running; or an independent financial company must take over the contract (as the Jarvis-Conklin Trust has done in America); or a separate electric tramway trust should be formed to buy and run the cars. This latter would no doubt be the best way if the money could be subscribed. It may yet be done, but for the present we may content ourselves with the consideration of the first case—a contract by the party manufacturing the cells. Now, we have the direct authority of Mr. Frank King, the chief engineer and manager of the Electrical Power Storage Company, that they, a powerful and responsible company, are now willing and ready to undertake the running and upkeep of electric storage cars for any tram line running more than twenty cars, for a price equal to two-thirds of the receipts. Not for five or ten cars, but for any reasonable number, say twenty or thirty cars. A large item in the cost of electricity is the salary of a superintending electrical engineer, and this would be no more for fifty than for five cars. On this condition, and without including expenses in connection of the permanent way, or the repair of the car bodies, but including all costs of running and maintaining the car equipments, for this the offer is 66 per cent. of the receipts. This may be an offer that the directors of tramway companies in our large towns may like to take up seriously. In many cases the offer would not mean any benefit, and again in others, where operations are on a large scale, the offer would naturally be likely to allow of considerable modification. But let us see what it means.

The receipts per mile last year for the North Metropolitan, for instance, on their whole system was 13·52d. per mile; the total expenses over all was 10·9d. per mile. Two-thirds of 13·52d. would be 9d. per mile, evidently no improvement on the present, where 10·9d. is the total cost, including permanent way, repairs and management. But this is for several hundred cars, and our quotation for twenty cars would be very considerably modified for this number. Take, now, the Birmingham central tramways. It will be interesting to give the comparative cost of the various methods of traction for the last year—for all four methods are in use on these lines. They are as follows—

	Receipts.	Expenses.
Steam	15·67d.	10·99d.
Horse	11·02d.	9·79d.
Cable	12·83d.	6·33d.
Electricity	15·15d.	9·90d.

The cable cars, it will be seen, are more popular than horse, and they cost much less to run. Steam and electricity both earn far larger returns, and cost not greatly over the horse traction—electricity being one penny per mile cheaper than steam. Take the returns for the horse traction in Birmingham, 11·02d. per mile run, to be typical of other tramways, as it may well be. Then, taking two-thirds of the receipts as the price to be paid for electric traction, we shall have an expenditure for running the cars of 7·35d. per mile run. It lays with the tramway companies to say whether the cost of power, management of cars, and upkeep of the power equipment is worth accepting at this price, bearing in mind, also, that electric cars are far more acceptable than the horse cars, and that one-third of the added profits would be obtained without risk on their part. We think it may be worth while; and when a still larger number of cars is taken, with a contract price still more favourable, the consideration may be all the more worth while. Meanwhile, it may be interesting to give the published figures of an American storage car line. This is the Eckington and Soldiers' Home Railroad, at Washington, of which Mr. G. S. Patterson is manager. The road has been working successfully for upwards of five months, and the figures are given as average cost and summary of results during that time:

Mileage of five cars per day	471 miles.
Mileage per day per car	94 miles.
Mileage in 150 days per car	14,100 miles.
Number of cells per car	264 cells.

Cost of running per car mile:

Charging, etc., of cells	2·00d.	4·5d. per car mile
Labour	1·50d.	
Mechanical supplies	·75d.	
Sundries	·25d.	

In this case no renewals have yet been made, but the estimate is stated to be based on renewal of batteries after six months, the batteries being expected to run 16,000 miles without repair. The cars run over one gradient of 150ft. in length with 4·7 per cent. rise, and another of 1,000ft. of over 10 per cent. rise. The cars are frequently loaded with eighty passengers without apparent overtaxing of the cars. The average run on a single charge is twenty-two miles, and each car makes five trips a day. Two 40-h.p. dynamos are used alternate weeks for charging. Without wishing to put too much stress on these figures, may we not ask whether English electrical engineers intend to be left behind in storage as well as in overhead conductor traction? Storage batteries are used here to a far greater extent than in America. We know their habits and their cost, and we surely can show now what can be done for electric traction by their means. Electrical engineers are, indeed, ready. What do the tramway companies say?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RICHMOND (SURREY).

SIR,—I have forwarded to you a report of a discussion in the Borough Council of Richmond upon certain difficulties which have arisen between the Council (through their engineer) and the contractors (through their engineer) upon the question as to which are the best and most suitable plans to adopt for the purpose of supplying the borough with light by electricity. The engineer of the company appears to wish to adopt a plan which he considers best, and the engineer appointed by the Council obstructs the progress of the contract and is strenuously supported by the Council upon grounds set forth in the adjoined report. Would you through your valuable columns assist the residents of this borough to understand the position which they may probably be placed in should open rupture occur between the contractors and the Council, and litigation ensue, as the ratepayers of this borough have no means of knowing how their affairs are conducted in committee? The obstruction assumed by the Council and their engineer appears to be carried on through personal pique, as shown by classing the letter of the contractors as impertinent, when that letter appears to some simple folks as merely advocating a fair way of settling a question as to the best way of executing certain work; and the only excuse for calling the company's letter impertinent appears to be that the Council are told that their engineer is an obstructionist. It appears that rather than allow any of the well known scientific men, which have been submitted by the company to step in and solve the problem in question, the whole of the Council are unanimous in risking an extensive lawsuit, the cost of which may eventually fall upon the borough.—Yours, etc.,

W. J. WESTON.

Difficulties with the Electric Lighting Contractors.—The Electric Lighting Committee presented the following report: "The chairman reported that, acting under his instructions, the town clerk had written to Mr Baker, the solicitor of Messrs. Latimer Clark and Co., calling attention to the continued delay in submitting plans of the proposed buildings and otherwise, and read a reply received from Mr Baker, dated the 27th inst., intimating that the delay rested with Mr Shoolbred, the electrical engineer of the Council, who did not approve the plans submitted nor the system of mains desired to be laid by the company. Mr Shoolbred and Mr Murdock (the company's representative) were in attendance before the committee, and the subject was discussed at great length, but no result was arrived at. Mr Murdock was to report to the company his interview with the committee, and the town clerk was directed to reply to Mr Baker's letter."

Councillor Hensler moved the reception of the report, and observed that matters were now almost at a deadlock. Another letter had just been received from Messrs. Latimer Clark and Co.'s solicitors. The **Town Clerk** read this letter, which was as follows:

"22, Great George-street, Westminster, August 8, 1892.

"RICHMOND ELECTRIC LIGHTING.

"Dear Sir,—Referring to my letter of the 27th ult., and your reply of the 29th ult., I beg to suggest, on behalf of my clients, that as all progress in this matter has been stopped by the action of your engineer in unreasonably withholding his approval, a dispute or difference has arisen such as is contemplated by clause 21 of the contract, and that the same should be referred to a friendly arbitration. It would save expense and delay if one arbitrator only was appointed, and I give you as a choice of names, to any of which my clients would agree, the following: Mr W. H. Preece, Prof. Robinson, Prof. A. B. W. Kennedy, Dr. John Hopkinson, Dr. Bottomley, Mr C. E. Spagnoletti. You will no doubt agree with me that the arbitrator shall take into his consideration all the circumstances of the case, and also any extension of time that shall be granted for completion of the works. I trust you will do your utmost to expedite this arbitration as my clients are anxious to get the works (which might have been nearly completed by this time) in hand, and are very disappointed at the unreasonable objections raised by your engineer.—Yours faithfully,

"CHARLES EDWIN BAKER."

"F. B. Senior, Esq."

Councillor Hensler remarked that he need not say that whatever loss of time there had been had been entirely through the action of the contractors. The committee had facilitated them in every possible manner. Letters had been received as late as Monday evening, trying to get things passed through the Council next day without going to the committee. He begged to move that the letter be referred back to the committee with power to act therein. The **Mayor** asked if it was intended by the committee to refer the matter to two arbitrators. **Alderman Robinson** hoped that would not be done, and he did not think that the question of the delay should be submitted to the arbitrator at all. The questions relating to plant and the building might, he thought, be settled by their agreeing in a friendly manner upon one arbitrator. **Alderman Skrimshire** was sorry not to agree exactly with the object of the mover of the resolution. He knew a good deal as to the way in which these negotiations had been carried on. Had he been acting for Messrs. Latimer Clark, Muirhead, and Co., he should have been very sorry to have written such letters as had been written to the committee. If such a letter as the one just read had been written privately to himself he should have repudiated it without delay. It started by saying that progress with the work had been stopped through the action of the Council's engineer. If the letter were accepted that suggestion would be adopted to some extent, and there was not one word of truth in it. Progress had been stopped by the extraordinary action of Messrs. Latimer Clark and Co. themselves, right through. The committee had been more than anxious to fall in with their views, and those of the proposed company. Week after week and month after month, up to almost the very time when the work should have been completed—and it was not yet commenced—the most impertinent letters had been written, of which that just read was a sample. The Council ought not to treat upon a letter which began with a false statement. If it had said that "It is alleged by our clients that —" so and so, it would have been different. Surely the Corporation ought to stand by their engineer, who advised them what was the right thing to be done. He thought that the best thing that could happen for the interests of the town would be for the negotiations to come finally to an end. **Councillor Turpin** concurred. **Councillor Thompson** agreed. This was a most impudent letter, and he could not think that they ought to go to arbitration upon it. He should propose as an amendment that the matter be simply referred to the Electric Lighting Committee. **Councillor Hensler** accepted this suggestion. **Councillor Hilditch** did not see why the Council should go on at all in this matter. The letter was a most insulting one. He did not see why communications upon these matters of detail should go through solicitors at all; they should come direct from Messrs. Latimer Clark and Co. The **Mayor** said it was quite understood that the committee would not bind the Council to arbitration. **Councillor Hensler** agreed. It would report again to the Council.

THE CHICAGO EXHIBITION.

In our issue of the 15th of July we said that while the expense of exhibiting at Chicago was great, if the return, on the other hand, was likely to be at all commensurate, the trade should go ahead and combine to make a show worthy of a great industry, and not be content that it should comprise only a few paltry exhibits which, instead of leading the visitor to think of what he may expect to find in this country, is more calculated to cause him to think of what he may not expect to find. In the issue following we gave a copy of a circular which had been sent out by the secretary of the London Chamber of Commerce to the Electrical Section, with the object of ascertaining how far the members were disposed to support Mr. Preece's suggestion that a suite of rooms should be fitted up and

other two (Nos. 12 and 29) were H cells of the pattern described by Lord Rayleigh.

These cells were compared with the standard at the Cavendish Laboratory, with the results shown in Table II., which gives the differences between the four cells and the standard in hundred-thousandths of a volt.

Values of Berlin Cell Standard in ·00001 Volt.

Date.	July 26th.	July 27th.	July 29th.
Temperature.	16·1	15·9	15·9
Cell No. 69	− 15	− 18	− 14
„ „ 71	− 11	− 15	−
„ „ 29	− 36	− 35	− 36
„ „ 12	− 39	− 39	− 39

On July 29 cell No. 71 had been taken away.

Dr. Kahle kindly determined the differences between No. 69 and each of the other cells before they left Berlin. Values for these same differences can be obtained from the above Table II. We thus get Table III.

Table III.—Differences between Cell No. 69 and the others sent from Berlin.

Date and place of observation.	No. 71.	No. 12.	No. 29.
July 19, 1892, Berlin	− 2	29	29
July 20, 1892	− 4	28	25
July 21, 1892	− 4	25	26
July 26, 1892, Cambridge.	− 4	21	24
July 27, 1892	− 3	19	20
July 29, 1892	—	22	25

Thus the relative values of the cells as found at Cambridge are practically the same as those found at Berlin; while taking the E.M.F. of the Cambridge standards as 1·4342 volts at 15deg., that of the Berlin cells with porous pots is 1·43405, and of the Berlin H cells about 1·4338

The value actually found by Dr. Kahle for the E.M.F. of the porous pot cells is 1·4341 volts, so that the agreement is complete. In all the above it has been assumed that the resistance of 106·30 cm. of mercury is one ohm, and that the amount of silver deposited per second by a current of one ampere is ·001118 gramme.

The H form of cell in all cases examined at Berlin has a slightly lower E.M.F. than those with the porous pots, the difference being about ·0003 volt.

Appendix IV.

On the Standard Condensers of the Association, and on certain Resistance Coils.

BY R. T. GLAZEBROOK, F.R.S.

The report of the committee for 1890 contains as an appendix a very full account of the tests on the standard condensers belonging to the association. It was there stated that while the insulation resistance of No. I. was very high, that of No. II. was not completely satisfactory. No. II. was therefore taken to pieces and set up afresh. Its capacity and also that of No. I were determined afresh, using the commutator method described in the previous paper.

The following values were found :

Condenser No. I.

Date.	Capacity in microfarads.	Mean of each series.
December 23, 1890	·021059	
„	·021052	·021050
„	·021046	
December 29, 1890	·021044	

Condenser No. II.

Date.	Capacity in microfarads.	Mean of each series.
December 23, 1890	021396	
„	021392	·021395
„	021399	
December 23, 1890, afternoon	021365	
„ „	021399	·021389
„ „	021403	
December 29, 1890	021381	
„	021409	·021390
„	021389	
Mean of the whole	0·21391 microfarad.	

The different values in each series correspond to different rates of revolution of the commutator.

The value found originally for the capacity of No. I was ·021024 microfarad; it would appear therefore that it may be slowly increasing. The capacity of No. II has been changed by being taken to pieces and from ·022515 to ·021391.

The two condensers were also compared directly Assuming the value of No. I. to be ·021050, that of No. II. was found to be ·021390, practically the same value as that given by the commutator.

As a further check on the values, a mica condenser was compared with the two in the usual way. The values found were:

Date.	In terms of I.	In terms of II.
December 29, 1890	·5017	·5013
January 1, 1891	·5013	·5012

In March, 1892, the insulation of the condensers was tested by the secretary and Mr. A. S. Bowley. They were both found to lose rather less than 1/600 of their charge per one minute.

A divided condenser, Elliott No. 144 CLC No. 3 was compared. The results are interesting, as showing the effect on the capacity of the time of charging, and are given in Table III.

The first observation in each case, marked as 0", was made by connecting the galvanometer and then momentarily making the battery circuit for a very small fraction of a second. The observations on the condenser ·2 show that there has been no appreciable change in the relative value of the Standards I. and II. The observations throughout are accurate to about one part in 10,000.

Table III.

Nominal value.	Time of charging.	Value in terms of I.	Value in terms of II.
·05	0"	·05022	—
—	5"	·05072	—
—	10"	·05080	—
·05	0"	·05055	—
—	5"	·05106	—
—	10"	·05109	—
·2	0"	·1988	·1981
—	2"	·1999	·2002
—	5"	·2007	·2009
—	10"	·2010	·2013
—	20"	·2012	—
·2	0"	·2003	—
—	2"	·2018	—
—	5"	·2027	—
—	10"	·2033	—
—	20"	·2039	—
—	30"	·2046	—
·5	0"	·5032	—
—	2"	·5058	—
—	5"	·5078	—
—	10"	·5081	—
—	20"	·5092	—

During the process of the work Mr. Bowley compared several of the resistance-boxes of the association together. As these are used as standards in many experiments, it will be useful to put the results on record.

Box Elliott 1,253 is a Wheatstone's bridge box of platinum-silver in legal ohms, said to be right at 18deg. Assuming that the two 1,000-ohm coils of the bridge are equal (and the experiments showed no appreciable difference), the following values were found for certain coils in terms of a nominal 10,000 ohms taken from 1,253.

Nominal value.	Elliott, 1,825.	Value found.
10,000		10,012
20,000		20,024
30,000		30,034
40,000		40,049

Nominal value.	Nalder, 1,870.	Value found.
100,000 No. 1		100,042
„ No. 2		100,044
„ No. 3		100,050
„ No. 4		100,034
„ No. 5		100,042
„ No. 6		100,042
„ No. 7		100,052
„ No. 8		100,032
„ No. 9		100,047
„ No. 10		100,052

The temperature of all the coils was about 15·6deg. C.

Thus the box Elliott 1,825 is right at about 4deg. below the box 1,253, while the box Nalder 1,870 is right at about 1·5deg. below 1,253.

At the conclusion of the report of the committee,

The **President** invited Prof. von Helmholtz to give the opinion held by the German authorities on the English standards.

Prof Helmholtz said they in Germany were in the same position as the English scientists. At the congress of 1884 it was determined that the French Government should bring the decision of the congress before the European Governments, asking them to legalise the standards adopted in each country. As far as he knew, the communication of the French Government had been made, but no steps had yet been taken. At the time of the 1884 congress few measurements had been made, and several delegates undertook to make new measurements, the results of which were brought before a later congress. They had then to choose between figures which had a difference of 1 per cent., and they chose the proposal of Dr. Werner Siemens, which was the mercury column, one square millimetre in section, and one metre six centimetres in length, at a temperature of freezing point. That was the most accurate number they could then arrive at. Since then the work had been continued by Englishmen, Frenchmen, and Germans, and their conclusions were more in agreement; and they could take it for granted that 106·3 was right to about [illegible]th part of the whole. This value was quite sufficient for all industrial purposes, and it would be found of sufficient accuracy for most scientific purposes. There was, therefore, no reason to remain at the former definition of the Paris congress. In April of this year they, in Germany, brought the result of their experiments before the consulting committee; about that time they received information of the English proposals, and then found it was quite sufficient to accept the proposals of the British Association Committee, which had been laid before the Board of Trade. There were only minute points on which they thought there could be any difference. The speaker's experiments, as well as those of others, showed that solid wires were very uncertain, and liable to

alteration. For higher resistances they had used German silver, and they had found that this alloy, like many others, changed its resistance. If such a wire was wound round a coil it had a larger resistance than before, and altered within some weeks; they were never sure that wires which had at first the same resistance were still the same after some months had elapsed. They had tried other alloys which had a very low temperature coefficient, and with these it was possible to get a fair degree of accuracy. It was found that an alloy principally consisting of nickel and copper had a very small temperature coefficient, and had at the same time good mechanical qualities; so that if a new coil had been wound and heated several times in boiling water, one could get it in a state in which there would be no change. Such coils when compared with mercury standards had been found to be unalterable during the space of a year. The British Association wires, which were made of platinum, silver, and several alloys, showed good constancy, except two which had been frozen, seemed to suffer some modifications in their interiors; perhaps some fissures had developed which, failing to close again, would permanently alter the resistance. While a great number of these resistances might remain unaltered, it would be different in the case of a wire coil which had been used as a standard for centuries, for anyone to look into the interior to ascertain that if there had been any alteration. They were, therefore, of opinion that it would be better to keep up the old definition of the resistance given by Dr. Werner Siemens of the mercury column. They had made many accurate experiments with the mercury column; one of his (the speaker's) assistants had found out some new errors which hitherto had not been observed. Such a mercury column placed in a narrow tube, then again placed in a thick tube of glass and surrounded by iced water, became heated to one-third of a degree which was sufficient to alter the resistance, but that alteration could be measured; it was even possible to measure the degree of conductivity of the glass tube for heat by observing that little alteration of temperature. They must suppose that all the observations of the resistance of mercury hitherto had been a little too high, and that one must take care of these alterations. A curious thing in filling these tubes was the influence of capillary force. It was demonstrated that the mercury did not completely touch the glass tube if it was not filled in a vacuum. An easier way of filling was to place a drop of petroleum between the mercury and the glass, the mercury and glass then making better contact; they got less resistance from such a column of mercury than when the ordinary methods of filling were adopted. He thought that the value of the smallest resistance was probably right for a higher resistance showed that the filling of the tube was not completed. That was a reason why the square section of the mercury column should not be defined by length, for no one could measure with absolute accuracy the internal diameter of a glass tube of a square millimetre section. It seemed better to define the square section of the mercury column by weight. As far as it was possible to make out, the English standards were in so good an agreement with the independently made standards of the Germans that there was no reason to be divided on the question. For industrial purposes, the accuracy obtained was quite sufficient, he might say, for centuries. For scientific purposes, there would perhaps be some alteration necessary, but that was a question of time. Scientific people, who had a good definition of the standards they employed, could make the little calculation necessary to reduce them to their requirements. He thought that all nations were very near an agreement. They had been sent by the German Government to try to come to an agreement with England, and he hoped that America and France would come into the same agreement with them all.

CARDIFF ELECTRIC LIGHTING.

REPORT OF THE SUB-COMMITTEE AS TO ELECTRIC LIGHTING.

In pursuance of the resolution passed by the Lighting and Electrical Committee on July 21, 1891, your sub-committee, with the exception of the chairman, Mr. Councillor Vaughan, accompanied by the town clerk, the borough engineer, and Mr. W. H. Massey, the electrical engineer appointed by the Corporation, have to report that they visited London, Deptford, Bath, Havre, Paris, Brussels, Antwerp, Cologne, and Frankfort, with the object of obtaining the latest available information as to the progress of electric lighting, and the application of electricity to general industrial purposes. The members of your sub-committee (and in this relation the term includes the officials associated therewith) have held numerous meetings in Cardiff, London, and elsewhere, at which they have had the advantage of discussing the question generally with some of the most distinguished electrical engineers and scientists engaged in the particular class of work to which the sub-committee have been desired to turn their attention. Your sub-committee have everywhere been received with the greatest courtesy, and every disposition has been manifested to put them in possession of the fullest and most trustworthy information with regard to the development of electrical science. At various points in the course of their travels upon the Continent your sub-committee have found that deputations from other important cities and boroughs in this country, and also from Glasgow and Dublin, have been engaged on similar errands of enquiry and investigation. Your sub-committee regret that they had not the opportunity of meeting and exchanging notes with any of the members of such deputations, especially as some of them were placed in a position to devote more time and money in extending the scope of their enquiries than your sub-committee felt warranted in doing. It still remains for your sub-committee before sending in their final report, to visit two or three large northern boroughs, the municipal authorities of which have already embarked in electrical enterprise, and from whose example Cardiff may learn possibly what to avoid as well as what to adopt in matters of detail.

The conclusions that your sub-committee have so far arrived at are that the promise of advantage to the community at large to be derived from the development and application of electricity in the future, is such that a prudent municipality will not allow the control of what must practically be a monopoly to pass into the hands of any private individual or company, established for the purpose of profit. This is altogether apart from the still graver consideration of allowing any other body than the Corporation to come into the borough armed with parliamentary powers to tear up the streets and pavements of the Corporation. In order to secure the control of the supply of electricity in the borough it is incumbent on the Corporation, within two years of the granting of the provisional order (3rd July, 1891), to put down works, and be prepared to supply electric current over a certain compulsory area, which may roughly be defined as embracing the portions lying between Westgate-street to the west, Working-street and the Hayes to the east, Castle-street and Queen-street to the north, and Custom House-street to the south. It has been estimated that mains can be laid and works established within the area itself at a cost of about £30,000. Your sub-committee are, however, of opinion that whatever works are laid down should be designed not only to supply the electric current in the compulsory area, but also to form the nucleus of a supply station, capable of producing the whole of the electric current likely to be required throughout the borough during the term of the provisional order, viz., 42 years. In selecting a site for permanent works it is of the highest importance that there should be proper communication by siding with a line of railway, for the sake of obtaining cheap coal (in respect of which Cardiff has immense advantages over London and other places), and also access to an unlimited supply of fresh water for condensing and other purposes. Such a site the sub-committee believe could be obtained in the neighbourhood of the Dumballs, adjoining the timber pond. This site is sufficiently near the compulsory area to enable the lighting of that area to be carried on at very little more cost than has already been estimated, and what is perhaps of equal importance, by means of electrical currents of only moderate pressure.

The members of the Corporation are doubtless aware of the difference between incandescent and arc lighting. The one—incandescent or glow lamp—is generally utilised for domestic purposes, and the other—the arc light—for street lighting and illumination of large areas, such as railway stations, manufactories, and workshops. A different electrical pressure is generally used for each of these methods of lighting, what is called the low-tension current being employed for domestic purposes, and high tension for arc lighting, or for primary transmission. Without going into any technical details, it may be broadly stated that for economical reasons high-tension currents are necessary when it is required to distribute electricity to long distances or over large areas. It has already been demonstrated that this high-tension current can be transformed into low tension and thus made available for incandescent lighting by a very simple appliance, and your sub-committee are hopeful, from what they saw at Frankfort, and from what they gathered in conversation with electrical engineers abroad, that this transformation can be accomplished in an economical manner. In that case it is obvious that the most practical method of lighting a scattered district like the borough of Cardiff would be by concentrating the machinery in one spot, and distributing the electrical energy at a sufficiently high pressure over the given area, such current to be transformed as and where required. The objection to high-tension currents consists principally in the danger to life and property which unprotected cables having such currents are likely to cause. By a proper system of insulation, and laying the cables underground, however, this can be entirely obviated, but the higher the tension the greater is the cost of insulating and providing safety appliances, and that is one reason why your sub-committee call special attention to the moderate pressure likely to be required for distribution in Cardiff.

Assuming that the Corporation decide to undertake the supply of electricity throughout the borough of Cardiff, and to establish one principal station, the matters they would have to take into consideration in relation thereto would divide themselves into three main branches: 1. Street lighting. 2. Domestic lighting and shops. 3. Supply of power.

Street Lighting.—The best examples of street lighting that your sub-committee have inspected have consisted of a combination of arc lighting and gas, such as is seen at Brussels and Paris. Your sub-committee are of opinion that a somewhat similar arrangement would solve the difficulty with regard to lighting the main streets of Cardiff, and that by this method such streets within the compulsory area could, at a reasonable cost, be lighted as brilliantly as the streets of any city or capital in Europe. Your sub-committee would, however, suggest that in order to accomplish this end it would be necessary that the electric lamps should only be run from dusk to midnight, at which hour they should be extinguished and the ordinary gas lamps lighted. Appended to the report is a statement by the borough engineer, showing exactly what the cost of lighting the streets of the compulsory area by gas is at the present moment, and what he estimates it would be in the manner suggested by the sub-committee. At Bath the arc lamps are so far apart that the effect which otherwise might be produced is seriously impaired, and such a method of street illumi-

mation would not commend itself to the ratepayers of the town of Cardiff. In Bath, even with what your sub-committee consider insufficient lighting by electricity, the cost to the local authorities has been increased by £1,600 per annum over what was formerly paid for gas. The best example of electric street-lighting that your sub-committee have seen in England is that carried out by the Brush Company, in Queen Victoria-street, London, where the arc lamps are placed at an average distance of nearly 45 yards apart. The yearly cost of each lamp is £26, and the charge for lighting this street is therefore at the rate of about £1,000 per mile per annum. In this case, as at Bath, the lamps are run from dusk to dawn.

Domestic Lighting and Shops.—As the result of very full enquiries it appears at present that effective domestic lighting by incandescent lamps costs two-and-a-half times as much as gas lighting—light for light, and hour for hour, and in some places the cost is even greater than this. Yet, notwithstanding, your sub-committee found that everywhere incandescent lighting was in great and increasing demand; and there are cogent reasons for this demand, for experience shows that in private houses electricity is not only a light of luxury, but a light of health. As regards public buildings and business premises filled with expensive goods, economy is indirectly effected through the absolute freedom from noxious vapours and other destructive products of combustion; therefore, by the use of electric lighting in lieu of gas, the shopkeeper saves his goods, and the community its treasures and artistic decorations; and as against the extra proportionate cost of electric light is to be set the economy which can be effected by the much greater ease with which the light is turned on and off, so that the lamps themselves are not kept continuously burning, as in the case of gas. In private dwellings this is of the greatest importance. For instance, when persons move from room to room they instinctively operate the switches conveniently fixed near the doorways, and so use the lights only when, as, and where they are actually required. In the same way in a bedroom lights need not be kept burning all night, because the room can be instantly illuminated by turning on a switch near the bed, and thus the consumption of electric current only occurs when absolutely necessary. In London some of the companies are being worked at a profit, whose business consists almost entirely of the supply of low-tension current for incandescent lighting. But it will be scarcely necessary for your sub-committee to say that the stations of these companies are situated in the heart of the wealthiest districts, where great mansions, clubs, and hotels are concentrated, and where the demand for electric lighting is, perhaps, 10 times as much as it would be over an equal area in Cardiff. As an illustration, your sub-committee need only mention that some of the clubs in Pall Mall and neighbourhood spend over £1,000 a year upon the electric light.

Supply of Power.—At Frankfort your sub-committee witnessed a most interesting example of the ease and economy with which motive power can be transmitted over long distances. At Lauffen, about 110 miles away, a waterfall operated dynamos from 100 h.p. to 300 h.p. The energy was transmitted through bare overhead wires carried on insulators to the electrical exhibition at Frankfort, where it was used for lighting, and also for driving motors for working pumps and other machinery. Your sub-committee were informed that the loss in transmission over this enormous distance was less that 10 per cent. They also saw numerous electric motors varying in power from tiny instruments suitable for operating drills used by dental surgeons up to motors for working large printing machines, and heavy tools used for industrial enterprises, and other works requiring considerable power. The result of your sub-committee's enquiries satisfied them that the electrical motors are being extensively used, both on the Continent and in the United States of America, and that a considerable revenue is likely to be earned in the future by central stations supplying electricity for both light and power.

Your sub-committee also witnessed a most efficient, simple, and economical method of working tramways by electricity. In this instance, the wires were carried overhead upon very simple and not inelegant supports, which, as far as your sub-committee could judge, would, if raised a little higher, afford no obstruction to traffic on country roads, and it is probable that, in some of the suburbs of Cardiff, a similar arrangement might with advantage be introduced, as is the case in Leeds, where just outside the town an electrical tramway, worked by overhead wires, is on the point of being opened with the sanction of the Board of Trade, at the request of the local authorities; but there are numerous reasons why no system of overhead wires, however economical and efficient, would be tolerated in the streets of a large town like Cardiff, and consequently some method of underground distribution will have to be devised. Your sub-committee have inspected the various systems in operation in London and on the Continent, but having regard to local conditions and to the special requirements of Cardiff, they have not yet seen anything which they could recommend the Corporation to adopt without modification. The borough engineer and Mr. Massey are going very thoroughly into this matter, and your sub-committee feel sure that something worthy of acceptance will be designed. The same remarks apply to more simple questions with regard to the precise kind of machinery and appliances to be adopted, and other details of the constructional portion of the works which they consider it would be best to adopt; but they hope to deal with these matters fully very soon after they have completed their enquiries.

Dated the 30th October, 1891. Signed by P. W. Carey, chairman of sub-committee; Lascelles Carr; J. L. Wheatley, town clerk; W. Harpur, borough engineer; Wm. H. Massey, electrical engineer appointed by the Corporation.

ELECTRIC LIGHTING.

Statement by borough engineer of present cost of lighting compulsory area by gas, and estimated cost of lighting same area, partly by electric lighting and partly by gas, as recommended by report of sub-committee, dated October 30, 1891. The streets comprised in the compulsory area are at present lighted by means of the following lamps—viz.:

3—130-c.p. lamps at	£12	10	0	...	£37	10	0
1—150 ditto at	13	5	0	...	13	5	0
70—100 ditto at	6	17	6	...	481	5	0
1—100 ditto at	7	10	0	...	7	10	0
5—50 ditto at	6	0	0	...	30	0	0
29—16 ditto ordinary street lamps at	2	16	0	..	81	4	0
Total cost per annum					£650	14	0

To light the same streets partly by electricity and partly by gas, in the manner recommended by the sub-committee, the borough engineer estimates the cost would be as follows—viz.:

60 electric arc lamps, burning from sunset to midnight at	£12	0	0	...	£720	0	0
82 ordinary street lamps burning from midnight to dawn at present rate of prices, at	1	18	3	..	136	16	6
12 ordinary lamps burning from sunset to dawn, as at present, at	2	16	0	...	33	12	0
2 100-c.p. lamps burning as at present, at	6	17	6	...	13	15	0
1 150-c.p. lamp burning as at present	—			...	12	10	0
2 50 c.p. lamps burning as at present, at	6	0	0	...	12	0	0
Estimated cost per annum					£948	13	6

24th November, 1891. W. Harpur, Borough Engineer.

FURTHER REPORT OF THE SUB-COMMITTEE.

To the Lighting and Electrical Committee,—In accordance with the instructions contained in the resolution passed by the Lighting and Electrical Committee on December 15, 1891, by which resolution Mr. Alderman Carey, Mr. Alderman Jacobs, Mr. Councillor Trounce, the town clerk, the borough engineer, and Mr. W. H. Massey, were authorised to institute full and comprehensive enquiries into matters which had previously been brought to the notice of the Corporation in an interim report dated October 30, 1891, your sub-committee now beg to report that they have specially visited Leeds, Bradford, and Manchester, and that on more than one occasion when in London they have, either in company with the mayor and other members of the Corporation, or as a committee alone, visited also most of the largest and newest electric lighting centres in the metropolis, in order to arrive at a proper decision of the important questions referred to them. They have been to the Electrical Exhibition at the Crystal Palace, where they were much impressed with the numerous applications of electricity for the transmission of power, and here, as well as elsewhere, they had good opportunities of meeting engineers of high standing, with whom your sub-committee discussed many matters which must be taken into consideration when dealing with a business affecting, as this does in many ways, the interests of ratepayers in a rapidly-growing town like Cardiff.

The result of your sub-committee's investigations is to confirm generally the opinions expressed in the preliminary report before referred to, but to make the present report more complete in itself, your sub-committee think it well to state their views somewhat fully, at the risk of repetition, and of thus dealing with questions upon which the members of the Corporation are already well informed.

The remarkable extension of electric lighting in every direction is neither sudden nor transient, but it is the natural development of an industry now permanently established in this country. There are towns in which it appears to your sub-committee unlikely that the electric light can be carried on at a profit; but having regard to the special advantages which Cardiff undoubtedly possesses over many other places, because of its cheap fuel and abundance of water for condensing purposes, the powers obtained under the provisional order are certain to prove of value, and your sub-committee strongly urge upon the Corporation the desirability of itself retaining these powers, as well as the control over the streets and pavements.

By the terms of the Cardiff provisional order, the Corporation should, within two years from July 3, 1891, be placed in a position to supply current to the inhabitants of that portion of the town included in what is styled the "compulsory area," a district of a somewhat irregular shape, situated between the Great Western Railway Station, the Taff Vale Station, and Cardiff Castle, as outside points; and for the lighting of that district alone it would be possible to erect a small central station within the area itself; but your sub-committee feel sure that it would be more economical in the end, besides being fairer to the community at large, to put the electric lighting station on some convenient site outside the compulsory area, and in such a position as to be available for the lighting of other portions of the town as well. In laying down the requisite plant in the first instance it is quite easy to so arrange it that by making additions to the building and the machinery the whole may be gradually formed into a generating station suitable for the supply of electrical currents for both light and power throughout the entire borough; and by this means establishment charges, and expenses for staff and maintenance, would be reduced to a minimum.

It would be almost impossible to mention all the subjects to

which your sub committee have devoted so much of their time and attention, but allusion should be made to some of them. The utilisation of water power in connection with the new Taff Vawr mains, and the adaptation of refuse destructors, by passing the waste heat and gases through boiler furnaces for the purpose of raising steam to drive electric light machinery, are schemes which may all be realised to some extent in the not distant future, and yet they do not in any way modify the present needs. It is probable that electricity will play an important part in the propulsion of tramcars—an example of which was seen at Leeds, where a somewhat unsightly overhead wire conveys the current—and that suitable conduits might be combined with an underground system of electric light distribution, but in the existing state of affairs the latter must be looked upon as distinct in itself and be dealt with accordingly.

The vexed question of high versus low tension has frequently and in many forms been brought before your sub-committee, and it is clear that in order to make a commercial success of an electrical undertaking, regard must be paid to local conditions. It would be a suicidal policy to introduce into a sparsely populated town a low tension system such as may have proved successful in every respect in the heart of a densely packed city. The other extreme is to be avoided, of course, and it is satisfactory to know that for the lighting of the borough of Cardiff currents of only a moderately high pressure will be sufficient for the distribution of the electricity to all parts of the borough, and that the buildings and dwellings can be supplied with low tension currents.

Compared with the price of ordinary gas lighting, the cost of effectively lighting streets by electricity is decidedly greater if current has to be obtained from a supply company, but the Corporation would, as producers of their own current, be in a position to economically light the principal thoroughfares of the town by means of arc lamps or more probably by arc lamps and gas, after the manner indicated in the report which has already been referred to, while others of the main streets might be lighted by glow lamps of high candle power. But for many streets gas will for a long time prove to be the cheapest and most convenient illuminant.

In reference to private lighting, your sub-committee found, in many instances, that notwithstanding the increased cost of the electric light as compared with gas, consumers preferred the adoption of electric lighting, and they would on no account return to gas. The amount saved in stock, decorations, etc., formed an important item in this estimate.

Your sub-committee have not the means of forming a very exact estimate of the total cost of establishing the electric lighting station, and of laying the mains throughout the compulsory area; but, from figures submitted to them, and judging by what has been done elsewhere, they think that a sum of between £25,000 and £30,000 will be sufficient to begin with, to thoroughly equip the station, and to supply the district in conformity with the conditions imposed by Parliament, the cost depending, however, to some extent on the site chosen and on the price paid for it, or whether it be leased instead of being purchased.

Having regard to the fact that it will take about one year to get everything into working order, it would be unwise to postpone the consideration of the subject, and your sub-committee would, in conclusion, recommend that as soon as a site for the station can be obtained, the borough engineer and Mr Massey be instructed to prepare immediately plans and specifications upon which estimates may be obtained from builders, electrical contractors, and engineers for the whole of the plant necessary to enable the Corporation to carry out electric lighting works in accordance with the requirements of the provisional order.

Dated this 3rd day of May, 1892. Signed by P. W. Carey, chairman of sub-committee; T. Windsor Jacobs; W. J. Trounce; J. L. Wheatley, town clerk; W. Harpur, borough engineer; W. H. Massey, electrical engineer.

THIRD REPORT.

The proceedings of the sub-committees held on July 19 and 22, and August 2, were read, and also the following additional report of the sub-committee: Pending the fuller consideration of the interim report dated May 3, 1892, which was printed and circulated among the members of the Lighting Committee, a special committee consisting of the mayor (Mr Alderman Reed), and the chairman (Mr Councillor Vaughan), with the borough engineer, have entered into negotiations for obtaining a suitable site for electric light works in those localities which appeared to be the most convenient; but as the prices asked were prohibitive in some cases, while in others there seemed little prospect of the offers made on behalf of the Corporation being accepted without very serious delays taking place, your sub-committee were obliged to search for a somewhat less desirable place in other directions, and they beg to report that, failing to find a more favourable situation, some portion of the Corporation's own property at Canton can be made available if, as they believe, the supply of fresh water proves sufficient for the purpose in view. A trial hole is being sunk, and there would seem to be no doubt that water in very large quantity is to be had quite close to the surface. The subsoil is gravel, so that there will be no trouble with the foundations of buildings, etc., and as the plot of land adjoins existing railway sidings the facilities for getting coal are great. The only modification requisite in the scheme proposed by your sub-committee in their previous reports will be in regard to the pressure necessary for transmitting the electric current. The distance from which the supply is to be brought being greater, the cost of mains will, of course, be somewhat increased; but the efficiency of the system can be maintained by slightly raising the E.M.F. at the generating station, and the distinct saving in the amount allowed for the site will more than cover the extra sum which would have to be expended in the longer mains. Having inspected the works of the Bournemouth Electric Light Company, which are more than two miles out of that town, your sub-committee (consisting of the chairman, Mr. Alderman Jacobs, and Mr Councillor Trounce, with the borough engineer, and Mr. Massey) are confident that no real difficulty will arise in dealing on similar lines with the larger supply that will be needed for Cardiff; and the chairman, who has since his return from the Antipodes gone very thoroughly into the whole matter in London and other towns, finds himself in complete accord with the conclusions arrived at after so much care and thought by the other members of your sub-committee. As soon as the question of sites has been disposed of, plans can be prepared and estimates obtained; and your sub-committee would suggest that the work be now pushed on as quickly as possible.

Signed by Wm. M. E. Vaughan, chairman; Thomas Rees, mayor; T. Windsor Jacobs; P. W. Carey; W. J. Trounce; W. Harpur, borough engineer; W. H. Massey, electrical engineer.

LEGAL INTELLIGENCE.

ESK v. THE PLANET ELECTRIC LIGHTING COMPANY.

This case was one of considerable importance to electrical engineers, and was heard before his Honour Judge Bayley at the Westminster County Court on Friday last. The plaintiff is a traveller in electrical appliances, and he sued the defendant company to recover a month's wages in lieu of notice.

The facts of the case were that in July the plaintiff called at the offices of the defendant company in reference to obtaining orders for the installation of their electric light. In the first instance he saw Mr. Slatter, who was the manager to the company, and after a conversation on the subject he was told that, subject to his reference being satisfactory, he would be engaged for a month on trial to represent the defendant company out of doors. That took place on a Thursday, and it was arranged that the plaintiff should commence work on the following Monday morning if his reference was approved of. The reference was received in due course and on the Monday morning the plaintiff commenced operations. On the following day (Tuesday) the plaintiff called at the office of the defendant company, when he saw Mr Charles Scott, who was the secretary, and informed him that he was making some progress in the work, and had that day to go to Islington to see Major Probyn in reference to the installation of electric light at Bisley Camp. At the same interview he asked the secretary to give him some money on account of travelling expenses, but he refused to do so on the ground that the engagement had not yet been ratified by the company. Some rather unpleasant conversation then ensued, and it ultimately resulted in the refusal on the part of the secretary to pay anything, and he further expressed his regret at ever having made an arrangement which the directors would not ratify.

For the defence **Mr Charles Scott** was called, and said he had an interview with the plaintiff on the day after he commenced work, and he then asked him for some money on account of travelling expenses. Witness told him that the engagement had never been ratified by the directors, and, therefore, he had no power to pay him anything on account of expenses.

The **Plaintiff** then asked for the return of his reference, but witness refused to give it up on the ground that the document was a confidential one.

His **Honour** said he was of opinion that the plaintiff never was actually engaged, and, therefore, he was not entitled to make any claim. Judgment would be for defendants with costs.

COMPANIES' MEETINGS.

CUBA SUBMARINE TELEGRAPH COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Wednesday at the offices, Old Broad-street, Mr. Thomas Greenwood presiding.

The **Chairman** said their income had been about £1,100 more than that of the corresponding period of the previous year, but this was due to the fact that during a part of the half year ended June, 1891, with which they were now comparing, their lines were interrupted. The expenditure for the past half year had been about £80 less, although they had made rather an unusual charge for depreciation on stores and cable in stock, namely, £[illegible] for the half year. To fill the vacancy at the Board caused by the death of Mr Neal Bannatyne, Mr George Keith had been appointed. That gentleman had been their engineer and general superintendent in Cuba for over 15 years, and as he desired to remain in England he had been elected a director. In that capacity he would receive £200 a year, and in addition he would have £400 a year for taking the entire supervision of the cables, and the responsibility of looking after them with the assistance of one of the Company's servants in Cuba. In the event of the cables requiring repair Mr. Keith had undertaken to do the work, and he would receive, during the time he was away from England, the salary he would have received as general manager in Cuba. Altogether, by these arrangements, a considerable saving had been effected. He concluded by moving the adoption of the report.

Mr. Charles W. Parish seconded the motion.

In reply to a shareholder, the **Chairman** stated that the

Directors could give no further information than was contained in the report respecting the Company's suit against the Spanish Government. They were not damaged by the delay, and they did not press the matter.

The motion was adopted.

PIONEER TELEPHONE COMPANY.

An extraordinary general meeting of this Company was held at Winchester House, the Duke of Marlborough presiding, to consider a resolution for winding up the Company.

In proposing the motion the **Chairman** stated that the Company was formed originally to inaugurate a new departure in a new and important industry, and those who had supported it had been enabled to secure a reasonable profit on the risk they had undertaken. The Company had done some useful work, and it obtained certain important contracts with the view to the eventual establishment of an extensive telephone system throughout the country. They acquired the Mutual Telephone Company at Manchester, and thus constituted themselves, with their other acquisitions, a going concern. The interest in their Manchester undertaking had been purchased by the New Telephone Company, which had been formed out of the Pioneer Company, and thus the objects of the original company had been accomplished. There was no doubt that the New Telephone Company would be of great advantage both to the metropolis and the country generally; and by the arrangement which had been come to with the National Company a working alliance had been established under which there would be no waste of capital through rival systems, and there would be plenty of room for both companies. The public, too, would be greatly benefited.

The motion was adopted.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

The half-yearly meeting of this Company was held in Liverpool, Sir William B. Forwood in the chair.

Questions were asked about the recent issue of debentures, several shareholders complaining that they had not had the opportunity of subscribing for them. The **Chairman** explained that ample notice was given that the debentures were to be issued. No application was received from a single shareholder, and the Directors felt that if they had offered the bonds to them they might have been left with some for which they could find no customers. The bonds were taken by the Bank of Liverpool, and the Company had paid the bank 1½ per cent. to cover brokerage and all costs of issue.

The report was adopted.

COMPANIES' REPORTS.

BIRMINGHAM CENTRAL TRAMWAYS COMPANY, LIMITED.

Directors: Joseph Ebbsmith, Esq., chairman; M. J. Smith, Esq.; William Neale, Esq.; W. J. Carruthers-Wain, Esq., A.M.I.C.E., managing director.

Report of the Directors to be submitted to the shareholders at the eleventh ordinary general meeting, to be held at The Queen's Hotel, Stephenson-place, Birmingham, on August 24, 1892, at 12.30 in the afternoon.

The subjoined statement of traffic and profit shows that the profits of the steam department have been materially reduced by the charge for fuel (part of which is exceptional, and by the repairs to engines. The electric department shows a loss chiefly due to the heavy charges for renewal of batteries, but your Directors have now under consideration a contract for maintenance of batteries, which it is hoped will tend to material economy and profit of working. The cable department has again shown a gratifying result, and it is evident that upon routes of heavy traffic and severe gradients no other system of traction at present in operation can compete with the steel rope. The particular attention of the shareholders is directed to the diminution of profit consequent upon the constant increase of the charges for maintenance which, under the terms of the leases of the lines within the city as settled by our predecessors, we are bound to pay. How serious these are will appear from the following statement of the amounts paid in successive years: 1885-6, £249. 2s. 6d.; 1886-7, £654. 8s. 7d.; 1887-8, £739. 19s. 6d.; 1888-9, £1,935. 15s. 4d.; 1889-90, £4,683. 0s. 10d; 1890-91, £5,058. 1s. 3d.; 1891-92, £6,593. 3s. 2d. It is quite clear that so large and increasing an expenditure can only be met by an increased revenue. After careful deliberation your Directors are of opinion that this increase of revenue can be earned by the conversion of the Stratford-road line into a cable line, which would be a source of great profit to the Company and great convenience to the travelling public, and would increase the security of the Corporation. They have, therefore, with the concurrence of some of the largest shareholders, applied to the Public Works Committee of the Corporation to allow the expenditure of the whole, or part at least, of the sum of £68,580 (which the Corporation hold as security, and on the bulk of which they allow interest at the rate of 3½ per cent. only) to be applied for that purpose, and they recommend that the committee of the representatives of the shareholders may have authority given to them by the general meeting to assist your Directors in this matter. The revenue account shows a balance of £17,659. 4s. 11d., to which has to be added the sum of £1,262. 3s. 9d. brought forward from last year's accounts, making together £18,921. 18s. 8d. Your Directors recommend — 1. That the payment of the dividend upon the 5 per cent. guaranteed shares, amounting to £5,000, be confirmed. 2. That the balance of revenue account, amounting to £13,921. 18s. 8d., be carried forward pending the result of the application to the Corporation of Birmingham above referred to, and also pending the decision of the shareholders as to any reduction of the nominal amount of the ordinary capital. It has been represented to the Directors by many large shareholders, that the time has arrived for reduction of the ordinary share capital from £10 to £5 per share. Diverse views appear, however to be held upon the subject, and your Directors consider that the authority of the committee of shareholders might, with propriety, be extended to the consideration of this matter also. Mr. M. J. Smith and Mr. W. Neale (two of the Directors) retire, and, being eligible, offer themselves for re-election. Messrs. Howard Smith, Slocombe, and Co. offer themselves for re-election as auditors of the Company.

[The report also contains working accounts for 12 months of the various forms of traction used. The steam traction shows that the average cost per mile run was 15·96d. In the horse department it was 11·20d.; in the cable department it was 12·20d.; in the electric department—full details of which we give—it will be seen to be 15·39d. It is unnecessary for us to do more than give details of the electric working, which unfortunately resulted in a loss.]

ELECTRIC DEPARTMENT.

Average per mile run. d.	d.	Dr.	£	s.	d.	£	s.	d.
		Electric haulage:						
3·38		Wages	2,657	9	11			
1·65		Fuel	1,300	8	0			
·66		Stores	517	2	8			
·10		Water and lighting	78	7	6			
·09		Sundries	71	13	7			
——	5·88					4,625	1	8
		Machinery:						
·81		Wages	638	9	10			
3·22		Materials	2,529	7	11			
——	4·03					3,167	17	9
		Car repairs:						
·36		Wages	280	8	9			
·75		Materials	593	9	5			
——	1·11					873	18	2
		Traffic expenses:						
1·24		Wages	777	12	1			
·09		Water and lighting	68	11	9			
·01		Stores	9	5	3			
·08		Stationery, tickets, and punch royalty	61	4	10			
·02		Sundries	15	9	10			
——	1·44					1,132	3	9
		Permanent way and buildings:						
·02		Wages	12	6	9			
1·70		Materials	1,339	18	0			
——	1·72					1,352	4	9
		General charges:						
·11		Stationery and incidentals	86	7	2			
·11		Salaries	85	5	5			
·11		Compensation	87	3	0			
·55		Rates, taxes, and insurances	433	3	6			
·30		Professional charges	233	6	10			
·03		Sundries	25	3	8			
——	1·21					950	9	7
	15·39					£12,101	15	8

Average per mile run. d.	d.	Cr.	£	s.	d.
13·07		Traffic receipts.	10,281	0	4
·18					
——	13·25	Advertisements	141	4	7
	2·14	Balance to revenue account	1,679	10	9
	15·39		£12,101	15	8

Note.—Miles run, 188,760; passengers carried, 1,382,997.

NEW COMPANIES REGISTERED.

United Electric Sewage and Chemical Syndicate, Limited.—Registered by E. M. Walker, 132, Adelaide-road, N.W., with a capital of £5,000 in £1 shares. Object: to acquire certain patents relating to an improved process for the purification of sewage, and to develop and turn to account the same. Registered without special articles.

Hove Electric Lighting Company, Limited.—Registered by Deacon, Gibson, and Medcalf, 4, St. Mary-axe, E.C., with a capital of £40,000 in £5 shares. Object: to carry into effect two agreements expressed to be made between this Company of the one part and the Hove Commissioners and Messrs. Crompton and Co., Limited, of the second parts respectively, and to carry on the business of an electric lighting company in all its branches. There shall not be less than three nor more than five directors; the first are to be elected by the signatories to the memorandum of association. Qualification, £500. Remuneration: Chairman, £150 [illegible]

annum; ordinary directors, £200 per annum, divisible, with a further sum of 5 per cent. of the remaining profits after payment of 7 per cent. dividend.

Cambridge Electrical Engineering Company. —This Company has been formed for the purpose of carrying on the business of electrical engineers and contractors. The board of directors is composed of the following gentlemen: Mr. H. Eaden, Market-hill, Cambridge; Mr. C. A. M. Fennell, Litt. D., late Fellow of Jesus College; Mr. James D. Pryor, Furness Lodge, Cambridge; Mr. A. Barrett (electrical engineer), managing director; and Mr. B. M. Baily (who will join the Board after allotment and receive no remuneration as director for the first two years), who have power to add to their number. The Directors have acquired the business of electrical engineers hitherto owned and carried on by Messrs. Baily and Grandy, of St. Mary's passage, Cambridge, together with their rights and interests in certain patents connected therewith, and their existing contracts for illumination.

Collier-Marr Telephone and Electrical Manufacturing Company, Limited. —Registered by Nicholson, Graham, and Graham, 24, Coleman-street, E.C., with a capital of £100,000 in £10 shares. Object: to acquire as a going concern the business of the Collier Audible Telephone Syndicate, Limited, and with a view to the acquisition thereof to adopt and carry into effect an agreement, made March 17, between the Collier Audible Telephone Syndicate, Limited, of the one part, and E. Hampton, on behalf of this Company, of the other part, such agreement, however, being modified by an agreement expressed to be made between the same parties, and bearing date August 5, 1892; generally, to carry on business as manufacturers of and dealers in telephones, cables, wires, lines, accumulators, engines, etc., or any other apparatus or things connected with the establishment, working, and maintenance of telephone communication, or in connection with the generation, distribution, supply, accumulation, or employment of electricity. The first subscribers are:

	Shares.
H. Matthews, Darby-street, Manchester	1
H. J. Owen, 14, St. Mary's gate, Manchester	1
J. E. Pilling, 27, Leaf-street, Hulme, Manchester	1
G. Graham, 194, St. Clements road, Chorlton cum Hardy	1
W. Spencer, 322, Manchester-road, Hollinwood	1
T. Chapman, 311, Bolton-road, Pendlebury	1
W. Frost, Spring Bank, Irlams o'th Height, Manchester	1

There shall not be less than five nor more than seven Directors. The first are J. W. Maclure, M.P., G. C. Thompson, J.P., H. S. Foster, M.P., H. F. Herford, A. T. Collier, and A. Marr. Qualification, £200. Remuneration, £1,000 per annum, divisible amongst them as they themselves shall determine.

BUSINESS NOTES.

West India and Panama Telegraph Company. —The receipts for the half month ended August 15 were £1,882, against £1,630.

City and South London Railway Company. —The receipts for the week ending Aug. 14th were £721, against £653 for the same period of last year, or an increase of £68.

Change of Address. —MacLean's Telegraphic News Exchange has been removed from St. Stephen's chambers, Telegraph street, E.C., to 32, Cockspur street, Charing Cross.

Western and Brazilian Telegraph Company. —The receipts for the past week, after deducting 17 per cent. payable to the London Platino Brazilian Company, were £2,818.

Westminster Electric Supply Corporation, Limited. —The Board have declared an interim dividend for the half year ending June 30 last at the rate of £3 per cent. per annum. This dividend will be payable on September 15 next to all shareholders whose names are on the register on August 10, and the warrants will be issued in due course.

City Lighting. —The tender of Messrs. Pearson and Co., Fenchurch street, London, for the supply and erection of the constructional ironwork for the Meredith's Wharf Depot of the City of London Electric Lighting Company, Limited, has been accepted, the amount being £2,396. The plans and specifications were drawn up by Major General Webber, C.B., and Colonel Seddon, engineers to the Company.

PROVISIONAL PATENTS, 1892.

AUGUST 8.

14296. **Improvements in arc lamps.** Ben Death, 27, Martin's-lane, Cannon street, London.

14309. **Improvements in electricity meters.** Francis Teague, Ernest Francis Moy, and John Abbott Iliffe.

AUGUST 9.

14360. **An electric bell.** George Davis, 46, Brookbank road, Lewisham, London.

14363. **Improvements in the method of and apparatus for transmitting and receiving time signals over main and local electric circuits.** William Franklin Gardner, 28, Southampton buildings, Chancery-lane, London. *(Complete specification.)*

14395. **Improvements relating to electric furnaces for the treatment of auriferous sulphide ores and for other purposes.** John Walter Cann and Robert Edden Cannans, 433, Strand, London.

14410. **Improvements in combined fishing and life boats to be propelled by hydraulic mechanism actuated by steam, electric, or other known power.** Joseph Fletcher Green, Blackwall yard, London.

AUGUST 10.

14423. **Improvements in electricity meters.** Arthur Wright, 26, Park crescent, Brighton.

AUGUST 11.

14481. **Improvements in decorating chandeliers, gasaliers, lamps, and electric light fittings.** Harry Hateley, 128, Colmore row, Birmingham.

14489. **Improvement in governing devices for electromotors.** Thomas Cattrus, Elmwood Electrical Works, Camp road, Leeds.

14512. **An electric combination street alarm-box for fire, police, and other purposes.** Henry Binko, 34, Leadenhall street, London.

14533. **An apparatus for converting alternating currents of electricity into direct currents.** Richard Norman Lucas and Anthony George New, 12, Palace chambers, 9, Bridge-street, Westminster, London.

AUGUST 12.

14558. **Improvements in lampholders for incandescent electric lamps.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford, Lancashire. (Complete specification.)

14567. **Improvements in grooved wood cases for electric cables or wires.** Samuel Hindley, 126, Landsdowne road, Sheffield.

AUGUST 13.

14647. **Apparatus for controlling the electric current on putting electromotors in circuit.** Siemens Bros. and Co., Limited, 28, Southampton buildings, Chancery lane, London. (Messrs. Siemens and Halske, Germany.)

14658. **Improvements relating to electric accumulators or secondary batteries and to the manufacture of plates or electrodes therefor.** Arthur James Smith, 11, Southampton buildings, Chancery lane, London.

14659. **Improvements in and relating to electric accumulators.** Henry Harris Lake, 45, Southampton buildings, Chancery lane, London. (Frederick Clarence Jenkins, Germany.)

14660. **Improvements in and relating to the manufacture of plates for electric accumulators.** Jules Rousseau, 45, Southampton buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1888.

19043. **Insulating telegraph wires, etc.** Fowler. (Second edition.)

1891.

4838. **Incandescent electric lamps.** Bailey and Warner. (Second edition.)

12992. **Measuring electric currents.** Aron.

12831. **Curative electric belts, etc.** Russell.

13961. **Electrical parcel exchange system.** Bennett.

14217. **Telegraphic apparatus.** Sacco and Giacomini.

14817. **Electric tramcars.** Heys. (Brown.)

15768. **Distributing electricity.** Hall.

16091. **Electric circuits for lighting, etc.** Massey.

16113. **Suspenders for electric lamps.** T. H. and C. O'Brien.

17100. **Electric accumulators.** Lake. (Société Electrometallurgique Montechappi, Système de Khotinsky.)

1892.

1497. **Couplings for electric wires.** Shiels.

11403. **Electric generators and motors.** Goolden and Atkinson.

11424. **Telephone, etc., exchanges.** Dymond. (Strowger.)

11692. **Electric locomotives.** Pardon and others.

11698. **Insulators for electric wires.** Meyer.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3
— Pref.	—	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
House to House	5	[illegible]
Metropolitan Electric Supply	—	7
London Electric Supply	5	[illegible]
Swan United	3¾	[illegible]
St. James	—	[illegible]
National Telephone	[illegible]	[illegible]
Electric Construction	10	[illegible]
Westminster Electric	—	6
Liverpool Electric Supply	[illegible]	[illegible]
	[illegible]	[illegible]

NOTES.

Bombay.—The managers of the Petit Mills are introducing electricity as motive power in lieu of steam.

Church Lighting.—It has been arranged to light Free St. Paul's Church, Glasgow, by electricity, at a cost of about £200.

Italian Telegraphs.—A report recently issued shows a great development in the Italian telegraphic service during 1890.

Berlin Tramcars. — Electric light having proved satisfactory on the Berlin omnibuses, it will be adopted on all lines, including the tramcars.

A Large Contract.—The contract for 17 miles of electric railroad for 300,000dol. at Cuyadetta, U.S., has been given to Mr. H. Ward Leonard after severe competition.

Niagara.—Two turbines of 5,000 h.p. have been ordered, we understand, for the Niagara transmission plant from Messrs. Foesch and Piccard, water power engineers, of Geneva.

Munich.—The municipal authorities of Munich have sanctioned the lighting by electricity, to the extent of not more than 300 h.p., of the public streets of their ancient city.

American Brush.—The Thomson-Houston Electric Company own a controlling influence in the American Brush Electric Company, for which they paid two and a half million dollars.

A Warning.—An electrical engineer's apprentice named M'Connell was stabbed in Belfast on Thursday last week for refusing to stop singing "Ta-ra-ra-boom-de-ay." His condition is precarious.

Madras Telegraphs.—A through telegraph wire from Calcutta to Madras is about to be erected. The length of the new line will be 1,900 miles. Copper of a special thickness will be used.

Electric Launches.—The concession for use of electric launches at the Chicago Exhibition has been let provisionally to the Columbia Electric Launch Company, but it is probable other companies will also have launches running.

Coventry.—The Council, upon the proposal of Alderman Hill, have instructed the Electric Lighting Committee to take into consideration letters which have been received, and recommend to the Council a scheme for electric lighting.

Scottish Telephones. — The National Telephone Company have reissued their directory of the subscribers for the South of Scotland, which has grown so much as to necessitate its being reset in smaller type to keep it into a handy size.

Kinsale.—The Kinsale Town Commissioners will, at the next meeting, September 5, receive and consider tenders for the lighting of the town during the next 12 months. Application to be made to Mr. M. Hegarty, clerk to the Commissioners, Kinsale, Ireland.

Wolverhampton.—The Wolverhampton Town Council have approved of the Lighting Committee's report relative to the supply of electricity within the borough, and the appointment of a special committee to advertise for tenders for the construction of the necessary works.

Thunderstorm on the Continent.—During a violent storm on Monday at Vienna the buildings of the International Musical and Dramatic Exhibition, in the Prater, were struck five times by the lightning. Fortunately no one was injured, and only slight damage was caused.

Lightning at Osborne.—During a storm on the evening of Thursday last week a hayrick on Barton Farm, Osborne, Isle of Wight, the property of the Queen, was struck by lightning and totally destroyed, despite the efforts of the staff who had charge of the fire engine kept at Osborne.

Thunder at Bristol.—During the recent thunderstorm at Bristol, a remarkable and prolonged clap of thunder startled thousands of people. Quite a panic occurred in the centre of the city, many thinking that the earthquake of last week was about to be repeated in more violent form.

Glasgow.—The mains are now being laid in Glasgow with a view to the lighting of the central part of the town before the winter. They are designed on the principle, familiar in Westminster and St. Pancras, of bare copper bands 1in. broad by ⅛in. thick laid on earthenware insulators in iron troughing.

Wire-Table. — Messrs. W. T. Glover and Co. have issued a table showing relative dimensions, lengths, and resistances of pure copper wire, both standard and Birmingham wire gauge. The table is beautifully printed, mounted, and varnished, and should be hung in the office of every electrical engineer.

Mont Blanc.—A stout wooden observatory has been constructed for the summit of Mont Blanc, and is packed off to Chamounix. The attempt will be made to erect it during this summer. It is 25ft. high, in two storeys, with several rooms in each. Communication will at present be made by semaphore to Chamounix.

Edison Works.—Edison seems to have been unfortunate lately. Not long ago a department of the Schenectady Works was burned to the ground, and now soon after the new works recently erected by Edison at Ogden, New Jersey, for the treatment of iron ore magnetically, collapsed suddenly and four persons were killed.

Boston Edison Station.—A very complete description of the station of the Edison Company at Boston, U.S., by Mr. A. C. Shaw, is given in the New York *Electrical Engineer* for August 10. Great credit is to be given to Mr. Shaw for his very thorough and interesting description, which is illustrated throughout with photographs and detail drawings of all parts of this large installation.

Electric Launches at Chicago.—The contract for furnishing and running a fleet of electric launches for carrying passengers on the lagoons at the World's Fair, has been finally awarded to the Electric Launch and Navigation Company, of New York. The company will be required to build 40 launches, and the Exposition Company will receive one-third of the gross receipts.

Aluminium.—A valuable discovery of white clay, very rich in alumina, has recently been discovered near Cleveland, Queensland. Some excellent specimens of pottery have already been made from this clay, says a Melbourne technical paper, and a quantity has been shipped by the "Jelunga" to England, instructions having been sent to have it tested at the Birmingham Aluminium Works.

Bristol.—Mr. Rienzi Walton, Local Government Board inspector, has held an enquiry at Bristol relative to the application of the Town Council for permission to borrow £66,000 for the purpose of electric lighting. The town clerk explained the position, and said that walls and foundations had been erected. Mr. Preece attended and explained the plans. There was no objection to the application.

Birmingham Electric Cars.—A correspondent of the *Birmingham Daily Post* thinks it would be much better to run much lighter electric cars at Birmingham and run them more frequently. To prevent overcrowding at the centre of the town, in Navigation-street, he suggests the cars might be run twice from here to Wellington-road to once that they are run from Wellington-road to Bournebrook.

Technical Education in India.—His Highness the Nawab of Joonaghur, says the *Indian Engineer*, has subscribed 10,000 rupees to the building fund of the Sind Madresseh tul-Islam at Kurrachee, a magnificent building costing 2,000,000 rupees, consisting of about 40 rooms, and having accommodation for about 1,000 students, prayer halls, and a factory for technical education, which is a part of the system of the Madresseh education.

Brazil.—Tenders are invited for lighting the city of Belem do Gram-Para, United States of Brazil, by gas or electricity. Particulars can be had on application to the Brazilian Legation, 55, Curzon-street, Mayfair, London (where a plan of the city may be seen), or to the Brazilian Consul General, 6, Great Winchester-street, London, E.C. Tenders are to be sent by 30th November to the office of the Secretary to the Municipal Council of Belem do Gram-Para.

Cheap Gas.—Dr. Auer's mantle for incandescent gas lamps has been improved and perfected, and it is said that 50 c.p. can be produced at 20 per cent. less consumption than with ordinary gas burners. The competition with electricity is severe, if we are to believe the report that in Vienna the hotels prefer this lamp to electric light. However, the Wurtemberg factory of the Edison-Swan lamps can now supply incandescent electric lamps at one shilling each.

Underground Conduits for Chicago.—The Love system of electric traction, which we have recently described, was made the subject of a company with 10,000,000dol. capital. This has been bought up, we hear, by a combination of Philadephia, Boston, and Baltimore financiers, including Mr. Elkins and Mr. Widener, whose purchases in Chicago railway stock have sent those securities up very considerably. The bearing of these purchases seems evident.

Merthyr.—At the ordinary meeting of the Merthyr Tydfil Board of Health, held last week under the presidency of Mr. Thomas Williams, J.P., a motion was introduced by Mr. E. P. Biddle in favour of obtaining a provisional order under the Electric Lighting Act. He pointed out that they were now paying £1,500 a year for gas. Mr. V. A. Wills seconded, and the Board were unanimously in favour of the project, but, in the absence of the clerk, it was decided to adjourn the matter for a month.

Mains for Oldham.—Tenders are required for making and fixing concrete culverts and the laying of electric conductors, for the Oldham Corporation. Specifications and drawings can be obtained on application to Mr. Alex. B. W. Kennedy, 19, Little Queen-street, Westminster, or to the Town Clerk, Town Hall, Oldham. Tenders must be delivered to Mr. A. Nicholson, town clerk, by 2nd September. A fee of one guinea will be charged for the specifications and drawings, which will be returned on receipt of a bona fide tender.

Croydon.—Offers are invited for the transfer of the powers granted to the Council under the Croydon Corporation Electric Lighting Order, 1891. Tenders should state the terms offered, the system of lighting proposed to be adopted, and it is essential that an option should be reserved to the Council of repurchasing the undertaking upon terms to be named. Tenders should be sent to Mr. C. M. Elborough, town clerk, Town Hall, Croydon, endorsed "Tender for Electric Lighting Order," by 11 a.m. on September 15.

Leicester.—The Gas Committee of the Leicester Town Council invite schemes, together with tenders, plans, and specifications, for the supply of electricity to their "limited area" in the centre of the town. A plan of the town and of the area to be lighted and other particulars can be obtained from Mr. A. Colson, M.I.C.E., engineer, Gas Offices, Millstone-lane, Leicester, upon payment of £5. 5s., which will be returned on receipt of bona fide tender. Tenders, addressed to Alderman Lennard, chairman, and endorsed "Tender for Electric Lighting," to be delivered by 11 a.m. on September 8.

Heckmondwike.—Mr. W. B. Hutchinson, C.E., electrical engineer to the Heckmondwike Board, has returned the cheque for £10 for preparing specifications as not in conformity with his arrangements. The Board have referred to the resolution, and sent back the cheque with a copy of resolution. Mr. Rhodes thought the amount was to be merged in the commission, but Mr. Blackburn said commission was never mentioned. A long discussion was held on the establishment of the central station, but the whole question was eventually referred to a public meeting of the ratepayers.

Electric Tanning.—A writer in a French paper states that all the strayed dogs taken up by the Paris police and left unclaimed are, after being killed, handed over to an enterprising manufacturer, by whom the skins are tanned by electricity. Instead of taking seven or eight months to transform the skin into leather, as is the case by the ordinary system, electricity does the work in three or four days. The leather so tanned, moreover, it is asserted, is much better than that manufactured by the ordinary process, and when made up into ladies' boots and shoes is much admired for its soft and delicate qualities.

Fleet-street Lamps.—Fleet-street for some time back has been much encumbered on the pathway by the excavation of trenches and laying of pipes for the City electric lighting mains. Now all is smooth, and the line of scores of pipes of all sizes is simply indicated down the pavement by a wide joint in the asphalte. Wires have been drawn in by a chimney-sweep arrangement of flexible cane rods, and now all is quiet again. Down the street at intervals are rising the large bases of the electric lamp posts, rough painted red, and we may evidently expect to have light in our darkness before the fogs come round again.

Waterford.—The citizens of Waterford are not content to sit down under the weak-kneed policy of their Town Council with regard to the proposed abandonment of the electric light after many years' service. A public meeting has been called, and strong protests are to be made. Alderman Redmond has done good work in calling attention to the question, and has published very favourable opinions upon the electric light from Dublin, Bray, Carlow, Kilkenny, and Larne. Waterford was the first town in Ireland to adopt the electric light, and it will be a shame if the machinations of the gas supporters force it to be the only one to abandon the light.

Factor of Public Satisfaction.—Mr. Preece, in the evidence printed in the Electric and Cables Railways Report, said there was a curious thing which had developed in the United States with reference to electric railways, which is that the electrically-worked railways have always increased the traffic so much, that the term "factor of public satisfac-

tion" has now been introduced. In the West End railroad of Boston, 112 miles in total length, running about 300 cars, it is found that in the same districts the electric cars have carried an increase of 44 per cent.—that is, they are earning 44 per cent. more receipts, they are running 33 per cent. more cars, and each car carries 15 per cent. more people, and they call this percentage of increase the factor of public satisfaction.

Huddersfield Sewage Works.—At the Huddersfield Town Council last week the Health Committee's minutes were considered, showing that tenders, 20 in number, had been received for the fixing of an electric lighting plant at the sewage works at Deighton, and it was resolved that the tender of Messrs. Crompton and Co., Limited, of Mansion House-buildings, London, E.C., at £900, be accepted. After much objection by Councillor Chrispin to the expense, it was explained that gas would cost £150 a year, and the interest and maintenance of electric light only about £50 a year, as the heat from the destructor could be utilised. The works at Wolverhampton, visited by the committee, were lighted in this way. The minutes were passed and the tender accepted.

Printing by Electricity.—We received yesterday a copy of the *Birmingham Daily Gazette*, which has been printed, cut, and folded by the aid of electricity. We believe this is the first daily paper to be so produced and by current from a central supply station to replace steam power. A complete plant has been put down by Messrs. Fowler, Lancaster, and Co., for driving the whole of the machinery by electricity, and with current from the main of the Birmingham Electric Supply Company at the usual pressure of 110 volts. Thursday was the first printing of an entire edition of two papers published by the proprietor of the *Gazette*—the *Birmingham Daily Gazette* and the *Birmingham Weekly Mercury*—and henceforth the papers will be so produced. The two larger machines produce up to 20,000 papers per hour each.

Electricity in Agriculture.—We have several times alluded to the experiments of Mr. Rawson, of Boston, U.S., on the electric forcing of lettuces and other crops by electric light. A recent report states that the effect of this illumination every night in hastening the maturity of crops of lettuces is such that a single crop will pay for the cost during an entire winter. Prof. Bailey, after visiting the establishment declares his belief that the electric light will probably become a factor in vegetable forcing. One of the 13 houses devoted to this crop covers nearly a third of an acre, and from this covered space the cultivator takes at one crop as many as 2,000 dozen heads of lettuces twice the size of those ordinarily seen in the markets. The light used in this case is stated to be three 2,000-c.p. arc lights, which are kept shining all night throughout winter.

Telephoning to New York.—We gave last week a short note on a new invention for submarine cable relays, invented by M. Willot, for cabling direct from Paris to Algiers. Something more wonderful is at hand, if we are to believe the Paris *Figaro*, which says: "The great difficulty in the way of long-distance telephonic communication under water has now disappeared. In a few weeks messages will be transmitted as quickly and as easily from Paris to New York as from Paris to Versailles. This discovery, which is of great economical importance, is due to M. Willot, inspector of telegraphs at Paris. As soon as the necessary apparatus has been installed, M. Willot expects to be able to telephone from Paris to New York." We hope this new discovery will not resolve itself into a further application of cable relays to the Atlantic lines." *Figaro* distinctly says "telephonic communication." But it is a little hazy about the spelling of the inspector's name, so perhaps "telephonic" means simply "telegraphic" after all. Nevertheless, rumours have reached us time and again, even from one of our highest authorities in electrics, that determined attempts were to be made soon in Atlantic telephony, and that he was convinced the thing was practical—Mr. Preece's formula notwithstanding. We live in hope.

Cyrus Field's Will.—Cyrus W. Field had a large number of articles of historical interest in his possession at the time of his death. He leaves the paintings connected with the Atlantic cable laying to the New York Historical Society; and he leaves to his children (to be drawn for by lot) the gold medals presented by Congress, the Paris Exhibition, the merchants of New York, the State of Wisconsin and other bodies, the decoration presented by the King of Italy, the table on which the contract was signed, March 10, 1854, for connecting England and America by cable, together with the chair and other articles used on this memorable occasion, and the interwoven flags of England and America which floated at the masthead of the "Niagara" in the expeditions of 1857 and 1858, and of the "Great Eastern" while the cables of 1865 and 1866 were laid.

Electrical Fire Brigade Apparatus.—A full parade of the Bradford Fire Brigade took place on Tuesday for the testing of the new electrical apparatus, erected in order to obviate the necessity of ringing up the fire brigade. The installation is connected with the quarters of the superintendent, and with the residences of the permanent members of the brigade, who have been provided with quarters just opposite the fire station. The switchboard is placed in the dayroom, and immediately a telephonic communication is received from the Town Hall the whole of the 10 firemen can be summoned from their homes by two moves of the hand. The superintendent can also be called up at the same time. The electric switches consist of a small lever with a projecting knob, and they can be either moved separately or together, calling up either the 10 men or just as many as the occasion may be thought to require. Above the switchboard there is an index board with a black dial pierced with 20 holes. As the men are summoned a red disc appears in the eyelet, and this remains there until the fireman answers the call. When he does so there is a switch which he turns on, and the red disc disappears in the index frame. This experiment was witnessed by members of the Corporation, and was highly satisfactory.

Electro-Medical Apparatus.—Medical electricity is taking a very important position in hospital and private practice, as may be easily seen in the illustrated list of apparatus for this purpose recently issued by Mr. K. Schall, of 55, Wigmore-street, W. Mr. Schall has great facilities for producing useful and practical electrical appliances, having supplied a very large number of hospitals and medical men with instruments, batteries, and apparatus, many of the patterns having been designed by the doctors themselves for special requirements. Induction coils of various patterns are, of course, largely used, batteries for cautery and electrolysis, with indiarubber-sheathed platinum needles for destroying tumours. A special piece of apparatus we recently mentioned, made by Mr. Schall, is a small transformer set for obtaining currents for medical purposes from the ordinary alternating-current circuits. Lamps for investigation of the larynx, and ingenious arrangements for illumination, direct or by reflection, of the abdominal cavities, the ear, and the mouth, are illustrated carefully, and electric motors for dental or other operations are shown. Altogether the catalogue is a credit both to the medical profession and Mr. Schall, and its usefulness is not a little enhanced by a carefully written introduction, giving in a

brief space a considerable amount of practical information upon electrical subjects. The list of references includes the principal hospitals and some hundreds of prominent medical practitioners.

Croydon Tramways.—The chairman of the Croydon Tramways Company, Mr. W. J. Carruthers-Wain, at the recent meeting of the company referred in the following terms to the question of electric traction on their line: "I told you at the last meeting that we had made arrangements with the Electric Tramcar Syndicate on a system of which I am very fond—namely, 'Heads I win, tails you lose.' They were to run a certain number of cars at a fixed figure per mile, and the result to us has been satisfactory. The greater the facilities you give the public, the greater will be the advantages to you. You increase your traffic because you give the public, first of all a novelty, and when they have got tired of the novelty they find that the improved mode of traction in itself is a better method of getting about to their work or pleasure than the old types. I am sorry that from circumstances with which we have nothing to do, the Electric Tramcar Syndicate is not at present working that system of cars; but I hope that some arrangement will be made by them whereby they will be able to continue. I should like to see the whole of the line equipped and worked on the same terms, because you and your directors would be freed from responsibility and anxiety, and you would have nothing to do but to assemble every half-year to hear the declaration of the dividend." In reply to a question by Mr. Forbes, the chairman further said the Electric Syndicate, who had run cars upon the company's line with satisfactory results, were undergoing what was called domestic reconstruction at the present time, and he had no definite proposition from them. When their arrangements were complete, the board would endeavour to make an arrangement with them if the board were assured that they could carry it out.

Telegraphs and Telephones.—From the Postmaster-General's report, recently issued, it appears that the increase in the number of telegraphic messages of all kinds over that of previous years is 3,276,269, or 4 9 per cent. The London local telegrams show an increase of 335,152, or 6 per cent., the number being 6,081,276 as compared with 5,746,124 in 1890-91. An important alteration has been made in connection with the delivery of telegrams at night in the outlying portions of large provincial towns after the hour for closing the local branch office. Formerly porterage used to be charged from the head office on such telegrams, but now they are, like other telegrams, delivered free within the area of the ordinary free delivery of the local office. With regard to telephones, it is stated that the results of the working of the London Paris telephone, which was opened on 1st April, 1891, have been satisfactory. The number of conversations has increased from 1,221 during the month of April, 1891, to 2,157 in April, 1892, and it has been necessary in consequence to allocate a second circuit for the purpose. The charge is 8s. for a conversation of three minutes. As regards the acquisition of the telephones the Postmaster-General says: "One of the largest companies concerned has bought up most of its rivals, and gone a long way towards constituting the monopoly which Parliament desired to prevent. The expiration of the patents and the dissatisfaction evinced by the public at the want of development of the telephone system necessarily obliged the Government to examine the whole subject. Serious difficulties presented themselves, and the Government decided that the Post Office alone should possess the trunk wires between towns and co-operate with the companies in rendering additional services to the public. The object aimed at is to develop and cheapen the telephone service, as explained in the Treasury minute which was laid before Parliament in May last. A Bill founded upon the minute is under the consideration of Parliament."

Telephone Statistics.—From a census report on telephone companies in the United States during the census year (1890), it is possible, says the *Times*, to gather some idea of the enormous development which this new industry has undergone during the past decade. It is important to remember that at the beginning of the previous census year, 1879 80, the business of telephone companies in the United States amounted to little or nothing. During that year the business passed through the stages of an unprecedented development. This is strongly brought out by the fact that in 1880 there were no less than 148 telephone companies or firms reported as engaged in the business. In 1890 this number was reduced to 53; but this is the only respect in which a reduction is reported In every other respect the statistics show an enormous increase. The total amount invested in the business in 1880 was 14,605,787dol., in 1890 it was 72,341,736dol.; the gross earnings in 1880 were 3,098,081dol, in 1890, 16,404,583dol.; the gross expenses in 1880 were 2,373,703 dol., in 1890, 11,143,871dol.; the net earnings, which in 1880 were 724,378dol., in 1890 were 5,260,712dol; the number of exchanges had increased from 437 in 1880 to 1,241 in 1890; the number of telephones and transmitters, which in 1880 was 108,638, in 1890 was 467,356; in 1880 there were 34,305 miles of wire, in 1890 there were 240,412 miles; the number of employés in 1880 was 3,338, in 1890 it was 8,645; the number of subscribers, which in 1880 was 48,414, had increased in 1890 to 227,357. No record was kept of the number of conversations during the former year, but in 1890 they reached the enormous total of 453,200,000. The report points out, moreover, that, interesting as are these statistics, it is impossible by such methods to convey a proper representation of the actual changes that have occurred in the business of operating telephone companies during the decade from 1880 to 1890. Improvements in instruments and exchange switchboards, changing from grounded to metallic circuits, placing wires underground, extension of lines to extra territorial districts, and, finally, the introduction of long-distance service, combine to make the service rendered in 1890 more valuable and satisfactory to subscribers than the service rendered in 1880.

Strowger Automatic Telephone Exchange To dispense with the telephone girl entirely would be a sufficiently radical reform in central exchange practice, yet no less a change is proposed by Mr. Strowger, who has designed and perfected an automatic telephone exchange. If all that is claimed for it can be realised, then telephone directors may bless their stars and draw their dividends in peace. A picture is given in the *Electrical World* of August 13th of a Strowger central exchange. No switchboards are to be seen, no rows of listening ear-capped girls, only shelves of clock-like instruments and their batteries. The manager's chair even is empty, and the only person is a mechanic fitting up a new instrument. The method of working is simple enough. On the telephone shelf in the subscriber's office is a keyboard with five keys. Suppose he wishes to speak with No. 1,423. He presses the thousand key once, the hundred key four times, the ten key twice, and the units key thrice, and he is connected. No shouting, questions, or listening. To make all safe, a dial in front of him shows the number on his own telephone as well. He can now ring up and converse to his heart's content. If another subscriber wants to join in he can do so, but only to the extent of ringing the bell—he cannot speak through, and the first subscriber can finish his talk, and then, cutting out by a

release key, rings on to No. 2, who, we suppose, is waiting. The instrument which accomplishes all this is small, only 6in. by 4in. by 4in., but is naturally somewhat complicated. It has a disc of vulcanite, provided with circular rows of perforations, 100 in each row, $\frac{1}{10}$in. apart. Through these perforations extend wire connections to the main line wires, so that the wire of every subscriber comes to the instrument, passing up and ending in a good metallic contact. A moving arm or needle makes contact with these points. A combination of ratchets and pawls enables any contact to be made at will. When the conversation is finished, the telephone is hung up and the release key pressed. This sends a current, energises a magnet, and unlocks the ratchets and pawls, which return to zero. Each wire has, of course, one of these instruments, and as an instrument for 10,000 subscribers would have a dial of only 10in. diameter, it is claimed that quite large exchanges could be managed entirely without operators in attendance. Even if it should not be practicable in the larger and busier exchanges, there is a wide field of usefulness for such a system in the local exchanges and private telephone installations.

Irish Water Power.—Ireland is somewhat like Switzerland with regard to its large latent resources in water power, though unlike in the little use that is made of them, and it may be worth while at the present time to draw further attention to this fact. Not only for electric installations, now, we are happy to say, rapidly increasing, but for many manufacturing purposes by means of electric transmission might these waste powers in the future be usefully employed, as they have long been in Switzerland, and it would be well if electrical engineers in Ireland were to do more in trying to arouse public and private interest, by means of the papers and otherwise, in the sources of revenue that lie around waiting to be tapped. Without coal and without ports Switzerland has been able, by means of its lavish water supply, to erect and carry on fine factories and compete with other countries successfully in manufacturing products. A Foreign Office report just published—"Report on the Condition of Labour in Switzerland," Eyre and Spottiswoode, 6d.—brings the position out plainly in the following paragraph: "The manufacturing interests of this country mainly depend upon their rich water resources. Of the 2,322 factories which employed motive power at the close of 1888, 1,114 exclusively employed water power, and only 658 exclusively steam power, while 457 employed both water and steam; and, taken altogether, these 2,322 factories used 54,243 h.p. of water and 27,432 h.p. of steam, and only 717 h.p. of gas. The facilities which science is daily multiplying for the transmission of force by electricity, recently exemplified by the Lauffen transmission exhibited at Frankfort, are likely still further to accentuate this special feature in Swiss industry." We know that since 1888 immense strides have taken place in this department of science, and Switzerland now stands with Italy at the head of the European countries in the utilisation of natural forces. In America equal progress prevails, and in this and other commercial and educational departures American authorities are careful to have full reports from the centres where most efficiency and activity is found. Special commissions of professors, architects, and engineers are sent over from time to time to report fully upon all points that can aid progress. If a few travelling commissions could be arranged by the Irish colleges, or other authorities, to send over students and engineers to study and report upon the utilisation of water power in Swiss industries, this might give rise to a development of electric transmission plants that would benefit largely the financial and commercial aspects of the sister country.

Birmingham Electric Cars.—In a very full report that Mr. Carruthers-Wain (managing director) has made to the chairman of the Birmingham Central Tramways, he thus refers to the electric traction in the Bristol-road. He says: "I regret that my own idea as to the traffic upon this line has not been justified by the result. You will remembered that my estimate of the traffic was an average, taking the year through, of £250 per week, but the failure to reach this figure arises from causes with which you are well acquainted. There is no doubt that if we had had the means at our disposal to have conveyed the traffic, my estimate would have been fully justified. One set of the new batteries has been delivered. Had we been able to maintain the service originally contemplated, the difference in traffic would have been £2,700, which would have converted the deficit into a profit of £1,000. The undue strain put upon the rolling-stock, owing to the lines having been so constructed by the Corporation that they were too wide for the cars—*i.e.*, that they were out of gauge to the extent of as much as 1½in., resulting in the constant breakage of axles and wheels, and the consequent effect upon the working parts, and the enormous consequent strain upon the batteries, which were practically trying to grind a new groove in the metals—has naturally increased the maintenance charges to a very high figure. Again, the charge for permanent way is monstrous. It is absolutely impossible that ordinary repairs to a line which has only been constructed two years could in the past 12 months cost the sum of £1,352. That this is so is shown by the fact that on the small portion of line belonging to us beyond the city boundary on this route we have spent practically nothing during that time. The electric expenses in fuel will show a reduction this year. The new boiler will be able to do the bulk of the work, and owing to the price of fuel generally being reduced, we have been able to make a contract more advantageous to the company. After making many enquiries we have negotiated an arrangement with a company under which they guarantee, after the first cost for batteries is paid, to keep them in repair, and renew them when required for one penny per car mile run. The recent reduction in the electric service (which has, as the daily returns show, worked for the past few months with scarcely a hitch) has been due to the diminution of the number of batteries available for working, owing to others being worn out; and during that time the desire of the Board was not to incur indefinite expenses in batteries pending the investigations then in progress. A suggestion has been made that the electric and cable cars should be canopied. The company would have no objection if the Board of Trade and local authorities would agree to it, although it would add considerably to the weight, and therefore to the cost of haulage, but the local authorities have hitherto declined to allow canopies to be placed upon the cable cars. The following figures show the percentage of expenses to receipts in each branch for the year 1892: Steam, 75 per cent.; horse, 39 per cent.; cable, 50 per cent.; electric, 116 per cent.; total, 75 per cent. The gross receipts for the year ending 30th June are £152,238. 15s. 2d., as compared with £106,000 for 1887, and show an increase of £46,238. 15s. 2d. and a profit of £37,028. 1s. 9d., as against £18,000 for 1887, this being an increase of 43·62 per cent. on the receipts and 105·71 on the profits—*i.e.*, while we have increased the traffic by half as much again, we have doubled the profit. The whole of the departments have worked exceedingly well during the past year. There have only been trivial complaints from the public, and those mostly unjustifiable."

A BATTERY PROBLEM.

ON THE DETERMINATION OF THE RESULTANT E.M.F. OF TWO OR MORE CELLS JOINED PARALLEL.

BY W. A. RUDGE AND R. ALLEN, M.A., B.SC.

If the poles or terminals of a cell be joined by a wire, the available E.M.F. at the terminals will be reduced, and the reduction of the E.M.F. will bear a definite relation to the resistance of the wire as compared with the resistance of the cell. Let A B be the terminals of a cell of E.M.F., E_1, R_1 = resistance of cell, R_2 resistance of wire. On joining A B by R_2 the E.M.F. between those points will be reduced (the decrease of E.M.F. being inversely proportional to) in the ratio of R_2 to $R_1 + R_2$.

Let E = resultant E.M.F. after connection, then

$$E = E_1 \times \frac{R_2}{R_1 + R_2}, \text{ and } E_1 R_2 = E(R_1 + R_2).$$

If R_2 be very great, the E.M.F. is practically unaffected; if $R_2 = 0$, then the E.M.F. is reduced to 0 at the points A B.

Proof.—Let A E_1 B C be a circuit containing a cell at E_1, the points A and B being the terminals of the cell, C the wire used to join the terminals of cell A and B between which the E.M.F. is measured.

Fig 1

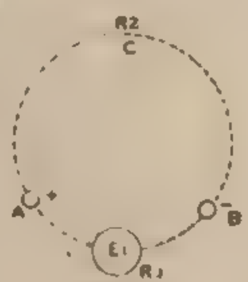


Fig 2

1. Consider the wire C removed. The cell will now have an E.M.F. = to E_1; as no current is passing E_1 will be independent of R_1.

2. Join A B by C of resistance R_2. A current will now flow, and the difference of potential between A and B will be lowered, the potential falling through A C B and A E B respectively, at rates inversely proportional to the resistances R_2 and R_1, therefore the available E.M.F. between A and B will be reduced in the ratio of R_2 to $R_1 + R_2$.

Then resultant E.M.F. $= E_1 \times \dfrac{R_2}{R_1 + R_2}$.

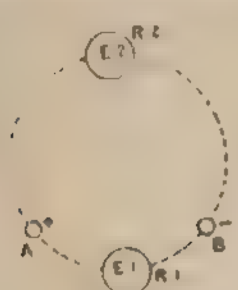


Fig 3.

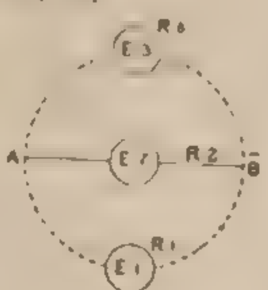


Fig 4

Consider the case when the external resistance R_2 contains an E.M.F. acting in the opposite direction to E_1 (Fig. 3)—*i.e.*, joined parallel. Then neglecting E_2, the available E.M.F. due to $E_1 = E_1 \times \dfrac{R_2}{R_1 + R_2}$, and neglecting E_1, the available E.M.F. due to $E_2 = E_2 \times \dfrac{R_1}{R_1 + R_2}$, and the total resultant E.M.F., E, due to both cells

$$= \frac{E_1 \times R_2 + E_2 \times R_1}{R_1 + R_2} \quad . \quad . \quad . \quad . \quad \text{(i.)}$$

But if $E_1 = E_2$, as is the case when two cells of similar construction are taken, then resultant E.M.F.

$$= \frac{E \times R_2 + E \times R_1}{R_1 + R_2}$$

= E, *which proves that when two cells of similar construction are joined parallel the E.M.F. is equal to that of one only.*

Combination of three cells of E.M.F.'s, E_1 E_2 E_3, and resistance, R_1 R_2 R_3, as Fig. 4. Neglecting E_2 and E_3, E_1 will be joined by a resistance, $\dfrac{R_2 R_3}{R_2 + R_3}$ ∴ available E.M.F. between A and B due to

$$E_1 = \frac{E_1 \dfrac{R_2 R_3}{R_2 + R_3}}{R_1 + \dfrac{R_2 R_3}{R_2 + R_3}} = \frac{E_1 R_2 R_3}{R_1 R_2 + R_2 R_3 + R_3 R_1},$$

Similarly, that due to $E_2 = \dfrac{E_2 R_3 R_1}{R_1 R_2 + R_2 R_3 + R_3 R_1}$,

and that due to $E_3 = \dfrac{E_3 R_1 R_2}{R_1 R_2 + R_2 R_3 + R_3 R_1}$,

and the resultant E.M.F. of the three cells

$$= \frac{E_1 R_2 R_3 + E_2 R_3 R_1 + E_3 R_1 R_2}{R_1 R_2 + R_2 R_3 + R_3 R_1} \quad . \quad \text{(ii.)}$$

If four cells be taken of E.M.F. E_1 E_2 E_3 E_4, and resistance R_1 R_2 R_3 R_4, and joined parallel as before, then resultant E.M.F.

$$= \frac{E_1 R_2 R_3 R_4 + E_2 R_3 R_4 R_1 + E_3 R_4 R_1 R_2 + E_4 R_1 R_2 R_3}{R_2 R_3 R_4 + R_3 R_4 R_1 + R_4 R_1 R_2 + R_1 R_2 R_3} \quad \text{(iii.)}$$

and so on.

In (ii.) let $E_1 = 0$, then E.M.F.

$$= \frac{E_2 R_3 R_1 + E_3 R_1 R_2}{R_1 (R_2 + R_3) + R_2 R_3} = \frac{E_2 R_3 + E_3 R_2}{R_2 + R_3 + \dfrac{R_2 R_3}{R_1}} \quad \text{(iv.)}$$

In (iii.) let $E_1 = 0$, then E.M.F.

$$= \frac{E_2 R_3 R_4 + E_3 R_4 R_2 + E_4 R_2 R_3}{R_3 R_4 + R_4 R_2 + R_2 R_3 + \dfrac{R_2 R_3 R_4}{R_1}} \quad . \quad . \quad \text{(v.)}$$

which gives formula for E.M.F. of two or three cells when there is an external resistance R_1.

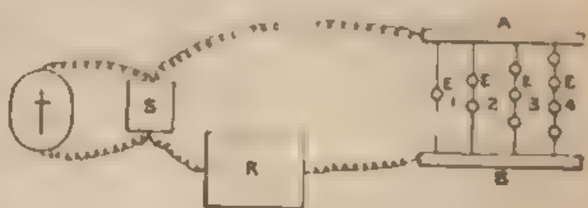


Fig 5

If R_1 be very great, then (iv.) and (v.) will become

$$\frac{E_2 R_3 + E_3 R_2}{R_2 + R_3}$$

and

$$\frac{E_2 R_3 R_4 + E_3 R_4 R_2 + E_4 R_2 R_3}{R_3 R_4 + R_4 R_2 + R_4 R_3}$$

For the experimental proof of the above a number of "Minotto" cells were prepared and arranged in four groups.

Groups.*	Consisting of	Relative measured E.M.F.	Relative measured resistances.
(1)	1 cell	1	1
(2)	2 cells	1·94	2
(3)	3 cells	2·92	4·25
(4)	4 cells	3·87	5·85

* The groups are afterwards considered as single cells.

The circuit was arranged as Fig 5. A and B were two brass rods fitted with binding screws, so that any combination of cells could be easily and quickly made. The resistance of R was altered for each experiment, so that the total in the circuit was 10,000 ohms. The galvanometer being a high-resistance reflecting one, the E.M.F.'s were considered to be proportional to the deflection.

RESULTS OF EXPERIMENTS.

Combination of cells.	Observed E.M.F.	Calculated.
Two cells.		
1 and 2	1·33	1·31
1 and 3	1·34	1·34
1 and 4	1·43	1·42
2 and 3	2·28	2·22
2 and 4	2·42	2·43
3 and 4	3·26	3·26

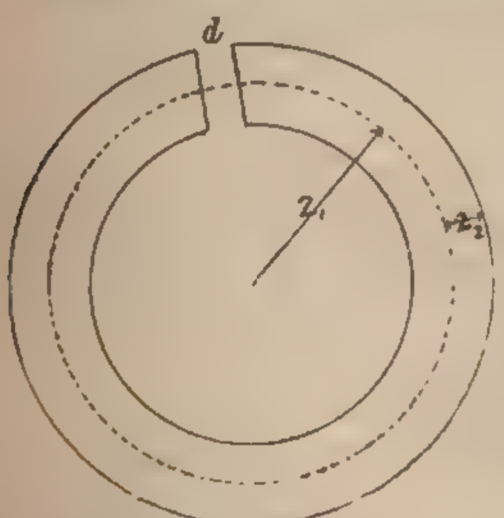
Three cells.		
1, 2, 3	1·51	1·51
1, 3, 4	1·64	1·63
1, 2, 4	1·53	1·57
2, 3, 4	2 51	2·52
Four cells.		
1, 2, 3, 4	1·71	1·70

The formulæ would probably apply in the case of dynamos or other sources of E.M.F., but we have had no opportunity of experimenting in this direction.

ON LEAKY MAGNETIC CIRCUITS.*

BY DR. H. E. J. G. DU BOIS.

Ever since the Hopkinsons' researches, a great many experiments on magnetic circuits have been made; mostly, however, in the form of measurements on dynamos of various types. Now the results obtained with a particular dynamo may offer a certain degree of interest, especially to its maker; but the utmost care has to be taken in generalising from such data. Quite apart from the consideration that ballistic measurements on dynamos suffer under the undue proportion their time-constant bears to the period of even the slowest ballistic galvanometer, dynamo circuits are not designed for giving interpretable scientific results, but for economy. For all these reasons it seemed to me a useful thing to thoroughly overhaul the whole subject by theorising and experimenting on the simplest conceivable type of magnetic circuit, and though the subject of these circuits has been amply discussed for the last 10 years, I venture to hope that its importance may warrant my bringing the first results of this rather lengthy investigation before Section A.



Consider a split-ring, magnetised by a uniform peripherical field. Let r_1 be the radius of the central circle, r_2 that of the circular section, d the width of the air gap. Assuming, then, as a first approximation that the magnetisation is uniform over the whole section of the ring and its direction everywhere peripherical, it may be shown† that:

$$N = \frac{2\left(d + r_2 - \sqrt{d^2 + r_2^2}\right)}{r_1 - \frac{d}{2\pi}} \quad . \quad . \quad . \quad (1)$$

where N is the well-known "demagnetising" factor which determines the amount of shearing over of the magnetic curve.

According to a theorem first enunciated by Kirchhoff, the above state of affairs will strictly occur when the external magnetising field becomes infinite; the direction of the lines of magnetisation is then bound to coincide with that of the applied lines of force. The values of N actually found must therefore approximate to those given by (1) as the field increases.

For weaker fields an exact calculation is impossible, but it may be stated that in this case

$$N = \frac{2\,d\,n\left(\frac{d}{r_2}\right)}{r_1 - \frac{d}{2\pi}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where the functional notation $n\left(\frac{d}{r_2}\right)$ means a number which is a function only of the ratio of width to radius of air-gap, independently of the rest of the circuit. This number, n, is practically equal to the reciprocal of the leakage coefficient as defined by the Hopkinsons.

It may be remarked that both the expressions given converge towards the simple form

$$N = \frac{2\,d}{r_1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

when the width of the air-gap diminishes more and more towards zero. In this case the value of n is unity, whereas for wider gaps n becomes a fraction. Moreover, the number n, as well as the factor N, vary somewhat with the magnetisation in a way which it must be left to experiments to determine.

These were carried out, under my advice, by Mr. H. Lehmann. A ring, about 15 cm. mean diameter and 2 cm. thick, was turned out of best Swedish plate and well annealed. It was wound uniformly all round with primary and secondary wire, and its normal curve first taken in the unsplit state. It may be remarked that curves of ascending reversals were taken throughout, the thickness of the iron giving so much time-lag that the step-by-step process would not give correct results. The magnetising field could be pushed to 400 C.G.S., the ring being immersed in a trough of iced petroleum.

The ring was now cut, beginning with a very narrow gap of a few tenths of a millimetre width. A small brass disc was fixed in the gap to prevent the iron from yielding to magnetic attraction, and a small secondary wound so as just to enclose the lines of induction crossing the air. Another auxiliary secondary coil could be moved around the ring so as to explore the leakage.

The general results may be summarised as follows:

1. For the very narrowest gaps the formula (3) holds, as it should.

2. As the width increases (2) becomes applicable; the values of n found from the throw due to the auxiliary secondaries, when substituted into (2), give numbers for N in good agreement with those found by the "shearing backwards" graphical process.

3. Both n and N remain practically constant up to values of I, about half the "saturation" value—*i.e.*, 850 C.G.S.; for higher magnetisations they begin to show an *increase*, N approaching to but *not* superseding the value given by (1), as was theoretically predicted above.

4. As a rule the *mean* magnetisation was deduced from the throw due to the principal all-round secondary; this was almost identical with the result given by the auxiliary secondary when diametrically opposite the air-gap. And by further exploration with this secondary it was found that an appreciable leakage began to occur only at about one-eighth of the circumference on both sides of the gap.

The numerical values of n within its range of constancy (which is the range of magnetisation mostly worked with) are of general interest, because they, or their reciprocals, depend only upon the ratio of width to radius of air-gap, as explained above. Moreover, it will hardly matter much whether the section of the gap be exactly circular so long as its area be the same; we thus obtain numbers of a certain utility in all questions of design where air-gaps occur. I prefer not to give the actual figures here, they being liable to slight corrections; they will soon be published in full in *Wiedemann's Annalen*, together with the experimental detail.

The result 3 that n finally *increases* with I, I consider to be fully proved by experiment; it corresponds to a final *decrease* of its reciprocal, the leakage coefficient. Now this is in complete disagreement with what is generally accepted as a dogma—viz., that leakage becomes more and more pronounced with larger inductions. This fallacy, as I cannot now help calling it, has generally been explained

* Paper read before the British Association at Edinburgh.

† See "Mathematical Theory of Ferro-magnetism," *Wied. Ann.*, xlvi., p. 494, 1892.

by the fact that the permeability of iron decreases, and so becomes more equal to that of the surrounding medium. If then Ohm's law held, there is no doubt but that more leakage would occur. But a true ohmic law does not hold in magnetism, or rather, the excellent results obtained by applying it in particular cases do not warrant its generalisation. Its complete failure to predict or explain in the present typical case may be hoped to bring home a little more care in its manipulation to those liable to grow too enthusiastic about magnetomotive force and reluctance.

On the other hand, physical theory is quite competent to explain the final decrease of leakage, which experiment has demonstrated to occur in the split-ring uniformly magnetised. For Kirchhoff's theorem already alluded to, in connection with the tangent law for the "refraction" of lines of induction at bounding surfaces clearly shows that those lines will tend to become more and more exactly peripherical as the applied field is being pushed up, thus diminishing the number of lines leaking away into the air.

In conclusion, it may be remarked that it is quite possible that leakage may yet increase in particular forms of circuits where the magnetising field is not uniform all round—*i.e.*, where coils are arranged in some haphazard way, more especially so if there be no coils near the gaps. It has to be borne in mind that on increasing the current in such coils the strong field so applied will finally overpower the self-demagnetising tendencies altogether, and arrange the lines of induction after its own fashion. Of course, exactly the reverse happens when weak fields are applied. I intend shortly to investigate this subject a little further by means of a large-sized ring electromagnet with 12 separate coils made from my designs by Messrs. Siemens and Halske.

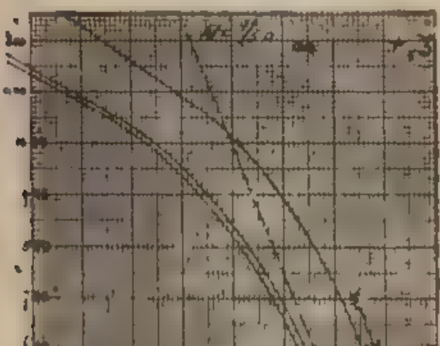
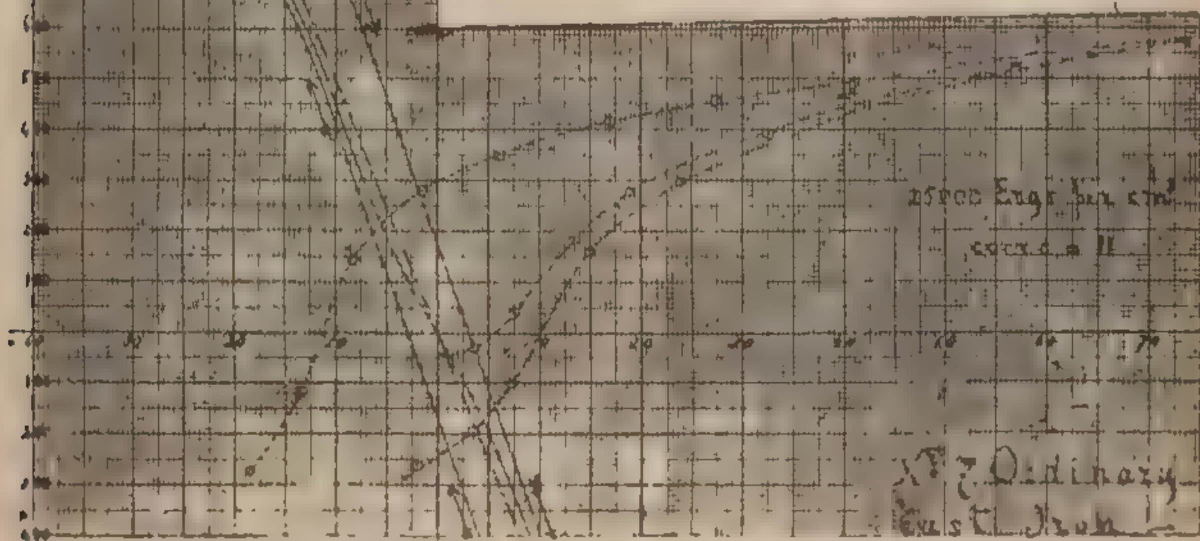



Fig. 3.

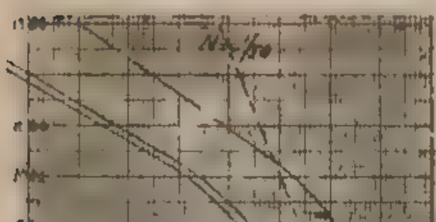
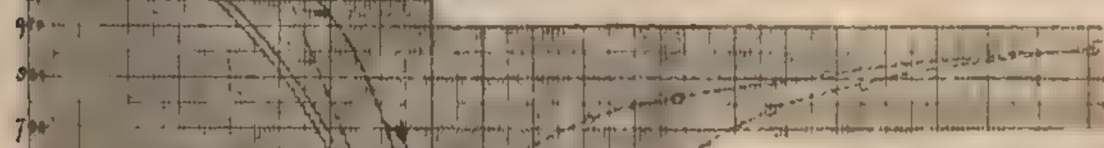
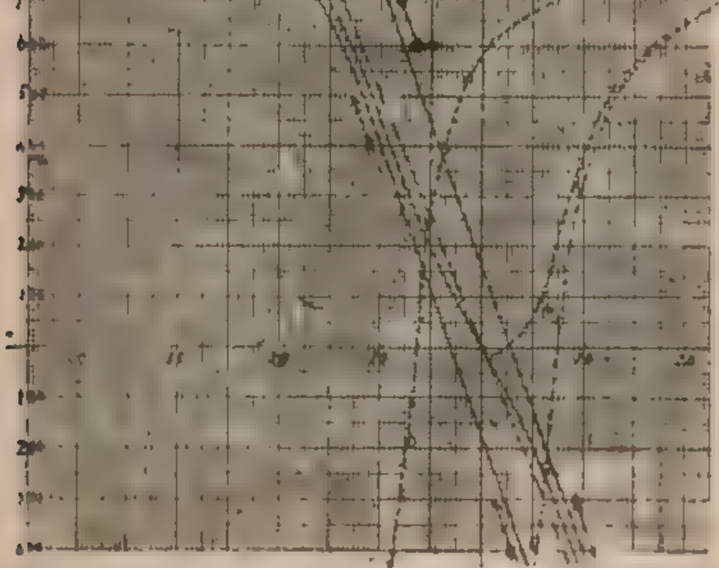




Fig. 4.—24,600 ergs per cm³. Coerr = 7. No. 6. Malleable Cast Iron.

ON A MAGNETIC BALANCE AND ITS PRACTICAL USE.*

BY DR. H. E. J. G. DU BOIS.

In a paper on "Magnetic Circuits and their Measurement," read to the Frankfort Electrical Congress in 1891, the principles of a magnetic balance were explained, with which magnetic curves of any material might be readily obtained in absolute measure. Theoretically it may best be defined as an electromagnetic system of variable configuration, the reluctance of which always naturally tends towards a minimum, the variations, however, remaining exceedingly small. I now propose to describe the instrument exhibited to the section; it is the outcome of a year's evolution of constructive detail. By means of a gauge belonging to the instrument, one test piece T, is cut to 15 cm. length and 1.128 cm. diameter,

* Paper read before the British Association at Edinburgh.

corresponding to 1 cm.^{2} section; the latter need not necessarily be adhered to if inconvenient, but has the advantage of obviating all further calculations, as will be seen below.

The coil C is 4π cm. long*, and wound with 100 turns, therefore near the middle it gives a field = 10 × current (in amps.). It will carry currents up to 30 amperes, which may be conveniently measured by the usual ampere meters; the corresponding range of field (0 to 300 C.G.S.) is all that is required in the great majority of cases. The test-piece is supported on two adjustable M plates, by means of which it may be readily set concentric to the coil, which is then slipped into position, the test-piece being automatically clamped by the plunger in the upright, V_2. Fig. 1 is a cut (one quarter of the natural size) showing the curved yoke, Y Y, of best Swedish iron playing over the stop, A, and screw, I. The latter is enclosed in a cap after calibration, so that the adjustment cannot be interfered with. P is a lead counterweight. Fig. 2 gives a perspective view of the instrument.

FIG. 1.

I have made a series of observations to find experimentally what function of the magnetisation of the test piece the resulting moment on the yoke (measured by compensating with the sliding weights) would prove to be. A small secondary was slipped over the middle of T, and connected to a ballistic galvanometer. It was found that the resulting moment was accurately proportional to I^2 (or B^2) up to values of $I = 1,300$ (or $B = 16,000$), with a test piece of 1 cm.^{2} section; this is all the range that is usually required; however, by using a somewhat thinner sample magnetisations up to 1,700 C.G.S. may be measured, as the tractive forces really depend upon the flux of induction through the test-piece only.

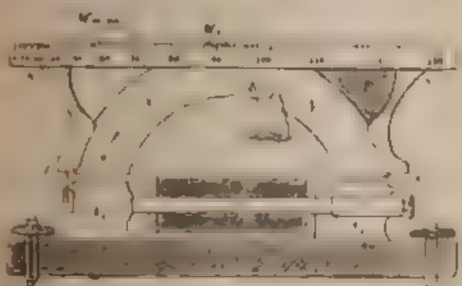


FIG. 2.

After this law had been experimentally established, it was evidently better to introduce a quadratic scale, along which two mutually independent weights, W_{100} and W_4, slide, of 100 and 4 grammes weight respectively. Accordingly the scale readings have only to be multiplied into the square roots of those weights—viz., 10 or 2—in order to obtain the absolute value of I in the sample. The smaller weight is used for the range $0 < I < 260$. It is then slid back to zero and measurements continued with the larger weight for $260 < I < 1,300$. The instrument does not indicate whether one is to take $+\sqrt{I^2}$ or $-\sqrt{I^2}$; but on plotting the results this becomes at once evident, one of the two points falling entirely outside the smooth curve joining the observations. It is therefore unnecessary to add a special permanently polarised arrangement with which to detect the direction of magnetisation.

The demagnetising factor, N, for a cylinder of dimensional ratio (length/diameter) 15 is about 0·12*). It is found in the balance to be reduced to 0·02, corresponding to the threefold ratio 45. This number was found by plotting the curve of a standard sample directly from the balance and shearing it backwards into coincidence with the normal curve obtained with a ring of the same material.

The result was, moreover, arrived at, that the usual rectilinear pseudo-axis of ordinates would do well enough up to half the saturation value, but that on the whole it was more accurate to introduce a generalised curvilinear shearing-base. This may be called an instrumental directrix, as it remains characteristic of the instrument when once determined by means of a standard sample; all the corrections due to the uprights, V_1 and V_2, the yoke, Y Y, the air spaces with their variable leakage, etc., are contained in it; it is used when ordinary unlooped curves of ascending reversals are being taken. In order also to correct for hysteresis of instrumental parts of the magnetic circuit, it is advisable to introduce two other directrices, the horizontal distance of which measures the coercive force of the apparatus. The left one is used for plotting ascending curves, the right one for the descending branches.

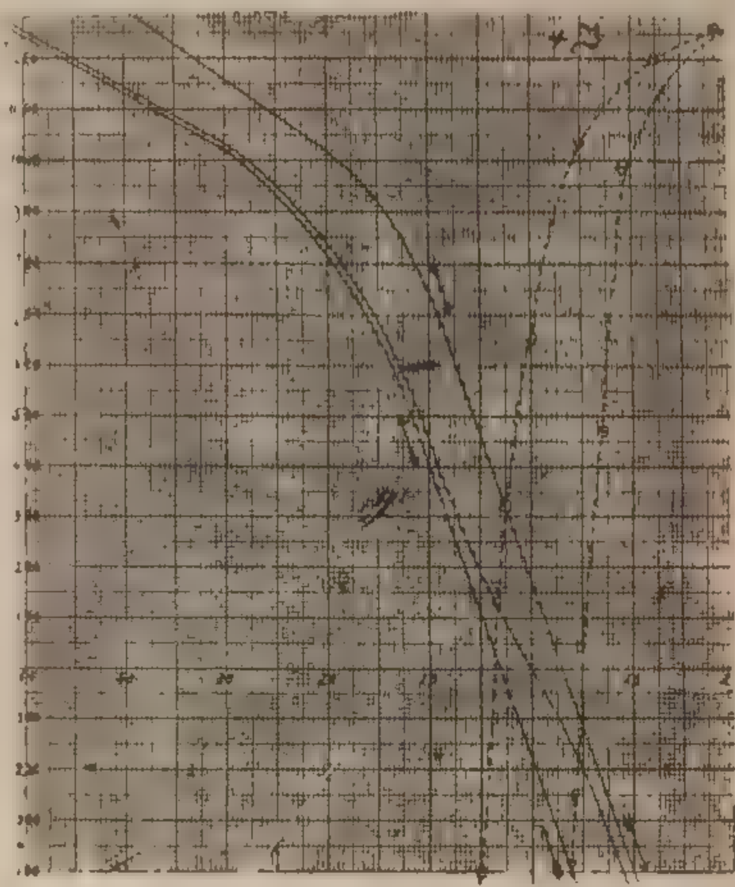


FIG. 5.—20,000 ergs per cm^3. Coerc. = 4. No. 9. Iron-Wire (annealed).

In conclusion, I may offer a few remarks on the practical use of the magnetic balance. The coil is placed in circuit with a reversing key, a good ampere-meter, one or two storage cells, and rheostats (preferably liquid) so as to admit of easily and gradually reversing, varying and reading the current between 0 and 30 amperes. In the first place, everything should be thoroughly demagnetised by diminishing reversals: accordingly, the yoke is slowly lifted by an arrangement provided for the purpose, while the reversing key is being quickly worked; it ought to remain in the lifted position when the instrument is not used, in order to spare the knife-edges, E. Then the coil is moved towards the observer and the test-piece gradually pulled out, reversing all the time.

* Really it is slightly shorter (12·2 cm.) to compensate the end effect.

* See the table in my "Mathematical Theory of Ferro-magnetism," *Wied. Ann.*, xlv., p. 498, 1892.

The method of taking readings will be sufficiently obvious from the above description; I will only add that, on account of magnetic instability, the position of the sliding weight is determined which will just pull the left-hand stop off the screw I, it has been found an unnecessary complication to introduce a secondary bell or telephone circuit as a criterion for the breaking of contact. The observer's ears and fingers afford a readier means, and after some little practice different observers alway find exactly the same reading to one or two tenths of a scale division (corresponding to a unit of magnetisation); this is more than sufficiently accurate.

The tenfold ampere and scale readings (or with the small weight, only double the latter) directly give abscissæ and ordinates respectively in C.G.S. units. The former are measured from the instrumental directrices as explained above; these are drawn on a transparent card belonging to the instrument, which is laid on the upper left-hand or lower right-hand quadrant of the squared paper, the plotting on which is thereby rendered as simple as when the usual method is followed. If the section of the test-piece is not 1 cm.^{2} it has to be measured, and the ordinates have still to be divided by it *after* the above process of plotting.

The dotted curves of Figs. 3, 4, and 5 were obtained with actual samples in the instrument exhibited. The full-drawn lines are the directrices, the middle one for ascending reversals is seen to considerably deviate from the straight line corresponding to $N = 0.02$ as the magnetisation increases beyond 850. From the malleable iron curve, Fig. 4, the first given for this material so far as I am aware, it may inferred that its magnetisation (for $H = 65$) is about 50 per cent. greater, and its coercive force as much less than those of ordinary cast iron. Fig. 5 was obtained with a bundle of 124 thin iron wires, representing a total cross-section of 1 cm.^{2}.

A NEW FORM OF WINDMILL FOR ELECTRICAL AND OTHER PURPOSES.*

BY PROF. J. BLYTH.

At the present time the employment of the form of energy known as the electric current to industrial purposes has become very extensive; and, in the near future, its application in that direction is likely to be still further increased. We have already many large private installations of the electric light. Every steamboat of any size is now electrically lit. In many places the current is used for the transmission of power. Already several large towns have adopted it instead of gas for street lighting, and the question of general house to house lighting is one whose solution only awaits a slightly greater economy in current production and distribution. It may be said that as yet the current is generated almost exclusively by dynamos driven by steam engines, so that it is merely a transformation of the potential energy of coal, and, so long as this is the case, it is obvious that any cheapening in its production can only arise either from an increase in the efficiency of the dynamo or of steam engine, or of both. Now these machines have attained so great an efficiency that there is scarcely any hope for much improvement in this direction. Primary batteries of several forms have been suggested and tried, but currents got from the oxidation of metals will always, I think, be too dear for practical purposes. Something may be expected from thermo-electric batteries, for here we have the direct transformation of heat into current electricity without the intervention of the wasteful middleman represented by the steam engine and dynamo. This, however, can hardly be said to have reached even the experimental stage.

Considerations such as these have led electrical engineers to look about and see if there may not be some other source of power at present unused, and which might be utilised for current production. Naturally, water power first suggests itself. The Niagara Falls have often been spoken about, and their available energy for that purpose calculated. In several places electric lights are run from water wheels where the fall happens to be near at hand, but in the great majority of cases the available falls of any size are so far from the centres of population that the cost of conducting the current almost prohibits their use. Much, no doubt, may be done by employing rapidly alternating currents of high voltage, and so diminishing the cross section of the necessary leads, but even then, when the distance is considerable, the cost of conduction comes in as a serious item. And, besides water power is not free. Although a fall may be unused just now, still, when it is proposed to use it, it immediately acquires a money value, and must either be vended or bought outright.

Next, after water power, comes the consideration of wind power, and it is about this that I am principally to speak. The wind is proverbially free, and is to be had everywhere, although it is of a very intermittent nature. Up till recently, this entirely precluded its use for current generation, as it was obviously impossible for it to work electric lights or do any kind of work where a steady current at a fixed time was required. But all this has been changed by the invention of storage cells or accumulators. These are now highly efficient, though a little too expensive; but disregarding the expense, we are now able to stow any quantity of electric energy and get a high return, even although a considerable time elapse between the storing and the using of it. No sooner was the accumulator invented than windmills for electric storage began to be thought of. At the York meeting of the British Association, Sir William Thomson suggested the construction of cheap windmills to run dynamos for charging accumulators, but, so far as I know, no practical trial was made till the summer of 1887, when I erected my first electric windmill in the village of Marykirk, Kincardineshire. At that time I procured a set of 13 accumulators and constructed a windmill of the old English type, having four arms and canvas sails. The length of the arms was about 14ft., and the sails were 8ft. by 3ft. The mill was provided with bevelled gearing at the top of a vertical shaft, and bevelled gearing below, so arranged that the driving wheel moved always in the same vertical plane, no matter in what direction the wind shaft pointed. The mill was turned into the wind by hand, having no tail or other gearing for keeping automatically head to wind. The dynamo was driven by a belt from the driving wheel, and with this I was able on two or three windy days to store my cells. Although the experiment was not on a very large scale, it was sufficient to show me that accumulators could quite well be charged, when the electrical connections were properly made, by a dynamo driven at the irregular speed characteristic of a windmill. Sails I found were not a great success, especially since I had no way of reefing them. To prevent them being torn to pieces, the mill had to be stopped when the wind was high—that is, just at the time when it should have been going at its best.

I remedied this partially. I altered the wind-wheel from the English to the American type, having a number of arms and blades of sheet iron. I also introduced the further improvement of doing away with the driving wheel being always made to go in the same plane. This is absolutely necessary if the windmill is to drive a saw-mill, a corn-mill, or anything of that sort, but for electrical purposes the dynamo can quite easily be attached to the wind-shaft platform so as to turn with the mill as the wind changes. In this way all gearing is avoided, as the dynamo can be driven by ropes from a large wheel keyed directly on to the wind shaft. This I found to answer very well so long as the wind had a moderate speed, but, like all other windmills, I soon found that it had either to be made self reefing or stopped altogether when a breeze came. This is obviously very unsatisfactory, as the best of the wind for storage purposes is lost, and hence this problem presented itself—viz., how to construct a windmill that would satisfy the following requisites: (1) it must always be ready to go; (2) it must go without attendance for lengthened periods; (3) it must go through the wildest gale, and be able to take full advantage of it.

A possible solution of the problem is presented in the Robinson anemometer, which consists of four hemispherical cups attached to four arms, and moving in a horizontal

* Paper read before the British Association at Edinburgh.

plane about a vertical axis. From the theory of this instrument, which is, however, only approximate, it appears that whatever might be the speed of the wind, the speed of the cups attained a certain terminal value, such that the couple due to the wind pressure was exactly equal to that produced by the resistance to the motion through the air, and the friction on the bearings.

Last summer I erected a machine of this kind, which has been considerably improved within the past three months. The cups are replaced by semi cylindrical boxes attached to four strong arms, each about 26ft. long. The opening of each box is 10ft. by 6ft., and the vertical shaft is a long rod of iron 5in in diameter. At the lower end it carries a massive pit wheel, which actuates a train of gearing, and drives a flywheel 6ft. in diameter with the requisite speed for driving a dynamo connected with it by a belt in the ordinary way. This machine worked most satisfactorily, and with a fair wind speed gave about 2 e.h.p. I also tested it in a strong gale by allowing it to run with no load, and the result was perfectly satisfactory, as a safe terminal speed was attained, and all racing avoided. Hence I think that electrical windmills, at least for small installations, are likely to assume this form, as there is no limit to the size and strength with which they may be constructed, and, if necessary, several could be placed in any well exposed position, each having its own dynamo and set of accumulators. During the past few months I have increased the power of the machine by adding an auxiliary box to each arm with a gap between it and the previous one. This I find to be better than merely increasing the size of the previous box. As the whole is a case of vortex motion, the theory is very difficult. Information can only be got from models and applying the principle of dynamical similarity.

Regarding the electrical connections necessary I may say a word. All that is needed is that the circuit be broken when the dynamo is running at less than the storage speed. This is easily managed by a governor attached to the dynamo shaft, and which makes and breaks contact in a mercury pool at the required speeds. I have also tried a form of governor which throws a greater or less number of cells into the charging circuit as the wind varies, and in this way the machine is always doing some work.

We may next turn to the uses for which windmills are specially applicable. These are:

1. *For Lighting Lighthouses.*—These are always in exposed situations, where wind is plentiful, and often in such out of the way places that stores and coal for generating the electric light in any other way could only be sent with difficulty.

2. *For the Lighting of Private Country Mansions.*—Here, whatever form of power is used, accumulators must be provided. The wind, I think, specially recommends itself, from its cleanly nature, if it can be applied without the trouble of much attendance.

3. For factories so situated that a suitable mill could be placed on the roof, and thus be in an exposed situation.

In closing, I may just refer to the probability that the present system of electric lighting by incandescence will be superseded by some method of getting light from cold sources. When we think that 99 per cent. of the energy spent in a gas flame is waste, as far as light is concerned, that a percentage almost as high in the electric light is also waste, we are strongly tempted to think that lighting by incandescence cannot be a final form. Recent discoveries have distinctly proved that rapidly oscillating currents send out waves exactly similar to light-waves, but only having a much greater wave-length. Attempts have been made to get alternate current machines of such frequency as to send out such waves. Should these be successful, then light will be generated with much less expenditure of energy, and windmills even of very moderate power may be all that is required. I can quite easily fancy the time coming when each house has its own little windmill storing current which may be used to drive such machines as those alluded to, and giving a light suitable for the house. We should not require to drive large steam engines in order merely to let us see each other or read a newspaper.

Prizes.—The Société Industrielle de Mulhouse offers for award in 1893 several medals, amongst which are the following. A medal for treatise on factory lighting—choice of system; comparison between gas and electricity; cost, maintenance, power absorbed; hygienic conditions, fire risks, arrangement of buildings; advantages and the reverse of electric light in textile industries, spinning, weaving, printing, machinery; description of existing installations, results and defects. A silver medal will also be awarded for the application of electricity in any way to the printing industry. Papers must be sent before Feb. 15, 1893, to the President of the Societe Industrielle, at Mulhouse. Further particulars can be obtained of the secretary.

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CONSULTING ENGINEERS FOR SMALL STATIONS.

There is an interesting paper by Mr. P. J. Salmon, of Galway, read before the North of Ireland Association of Gas Managers on August 9, given, with the discussion, in the *Gas World* last week. It was upon the necessity for a consulting engineer for small works—gas works, of course—and as the same necessity is present for small electric works even in a greater degree, and as this necessity will be greater as the number of main central stations increases, it may, perhaps, be well to refer more fully to this point. Mr. Salmon refers pathetically to the ignorant though well-intentioned interference of local committees, consisting of butchers, or grocers, and others, and relates his successful endeavours to raise the status of the various works in which he has been engaged into that of a respectable paying concern. His difficulties suggest the necessity of a consulting engineer to such works, both at the time of establishment and to uphold and supervise the efficiency. As every company, even with a good secretary and accountant, has its auditor, so should they have, he argues, their consulting engineer.

We need not enter into the question from the gas point of view—the gas managers are competent to discuss and settle the subject for themselves. From the electric lighting point of view, however, the problem is equally interesting and even more important, as the undertakings to which it may apply are not yet all started. One of the chief items of expenditure for the maintenance of an efficient central electric station is always that of the engineer-in-charge, who is responsible in all cases for the carrying on of the work, and in many cases for its actual erection. Now, a really competent electrical engineer is not and ought not to be a cheap man, and an item of three, four, or five hundred a year added to the expense of running a small central plant is a serious addition, and one often enough done away with. Nor is it likely that in a plant such as we are imagining—say of some five thousand lights or so—that the full attention of such a man would be occupied. The necessity, therefore, seems obvious for the introduction of a central station consulting engineer, who shall be called in, as the auditor is called in, to make quarterly inspection, analyse the accounts, and impartially report upon the progress and efficiency of the plant. His necessity is acknowledged theoretically at the time of the erection of the central station, but in many cases that could be named in the past his services have been dispensed with in the beginning, just that time when they would have been most valuable, and are only called in afterwards when the most he could do was to suggest modifications. The circumstances of each district are so diverse, and the necessity for careful choice so evident, that the wonder is that business men should ever have been led to institute erection of plant at considerable expenditure without careful discussion of every point of detail. Yet cases are by no means uncommon of the choice haphazard of, say, a high-tension system, or triple-expansion engines, or a certain type of

boilers, simply from imitation or a vague idea or assurance by the makers that they were the best, rather than from a sure knowledge that they were the best suited to these particular requirements. And it may well be that high-tension, triple-expansion, and complicated boilers, good in their way in large works, may, both on account of cost and absence of suitability, run away with that margin of profit which a properly thought-out system might have produced. Then, again, there are two matters which it is pre-eminently the function of a good consulting engineer to study—namely, economy of maintenance and facility for extension. Economy of maintenance does not mean alone proper choice of the system of production and distribution, but also the most careful consideration of the arrangement of the station, water heaters, steam economisers, mechanical stokers, condensing apparatus, and so forth; and the manager of a firm of electrical engineers who may be admirably suited for installing engines, dynamos, and mains, is not necessarily capable of arranging all these matters to the utmost satisfaction. Nor is the question of future extension always fully considered. The consideration of these matters, however, is the duty of the consulting engineer, and his fee in most cases is the most economical expenditure of the whole cost. As regards maintenance, again, for a comparatively small sum the station, otherwise overcharged with the salary of an experienced engineer, might be supervised in conjunction with several others, with all the advantage of the best advice and experience, and without the cost of paying the whole charge for such expert knowledge. When the fight is so keen between methods of illumination, when every attention is being turned to efficiency and cheapness of generation of current in the large towns, there should yet be the same possibility of efficiency, and even greater possibility of comparative cheapness, with the moderate-sized installations of our smaller towns, if arranged and supervised with the aid of the central station consulting engineer.

INSTITUTION OF CIVIL ENGINEERS.

The list of suggested papers for reading before this institution has just been issued, and the plan of suggesting papers might well be followed by kindred institutions. The electrical engineers have an institution, and it is a great pity that there exists so much jealousy within its borders. Successful societies, like successful companies, are successful because of the predominating influence of one or two master minds. It is so with the Civil Engineers, but not so with the Electrical Engineers, though the latter has, in a certain sense, been somewhat successful of late years. Its numbers have increased, its balance-sheet is respectable; but its influence is not to be compared with that of the parent institution. It cannot command the best papers. It hardly dare say, "Papers which have been read at the meetings of other societies or have been published cannot be accepted by this Institution." The fact is that "paste and scissors" and second-hand papers are admitted. Discussions are mainly within a ring fence, and new blood is not always welcome. Pushing business men make its boards part of the shop, and much of its proceedings has become to be looked upon as "merely a matter of business."

But to return to the suggested papers of the Civil Engineers, we find that the list contains between fifty and sixty different subjects upon which the institution desires information. Of course, this does not mean that the institution restricts itself to the accepting of papers upon these particular subjects, but the list is given as an aid to those who desire to prepare papers. That electrical engineering is taking a high place in general engineering work, may be seen from the fact that the list contains not less than nine or ten subjects in that branch of the profession. The suggested subjects are:

The cost of working electrical tramways, taking account of interest on capital, and of a sinking fund for depreciation.

The most suitable form of electric light mains, having regard to durability, economy of conducting material, and facility for making and laying house connections.

The risks of electric lighting to life and property, with the means to be taken to prevent or lessen them.

The best arrangement of engine for any given electric light station.

Electrical motors for (*a*) inland navigation, (*b*) ocean vessels.

The electro-deposition of copper.

On the application of water power and its transmission to a distance by electricity.

The design of electric locomotives.

The practical working of multiphase alternating-current motors.

In our opinion, the Institution of Electrical Engineers might well make out as lengthy a list of suitable subjects for paper to be read before it. Why, for example, should the Civil Engineers obtain interesting information as to electrical tramways, or to electric light mains, or to any of these other suggested subjects? We are quite sure, however, that, as at present constituted, a good deal of energy is wasted in fruitless directions; the younger members of the Institution of Electrical Engineers not having sufficient guidance, nor perhaps have they sufficient incentive to prepare papers. We are among those who contend that if a learned society can make its income and expenditure meet, it ought not to save up money—hence the Institution might well spend some of its surplus funds in subsidising the members who will prepare the best papers.

NOTE ON SOME EXPERIMENTS WITH ALTERNATING CURRENTS.*

BY DR. LOUIS DUNCAN,

Assisted by Mr. E. R. Carichoff and Messrs. R. H. and G. E. Hutton.

I must apologise for the brevity and scope of this paper, not because I sympathise with long papers, but because I had intended to embody in this the results of a considerable

* Paper read before the American Institute of Electrical Engineers.

amount of work done during the year, and I find that the rush of work at the last of our term has made it impossible for me to do more than write a note descriptive of the methods used, and to give a few illustrations of its use. Last fall I published a preliminary statement of a method for obtaining alternating-current curves, and it has proved so satisfactory that we have used it in a number of investigations of alternating-current phenomena.

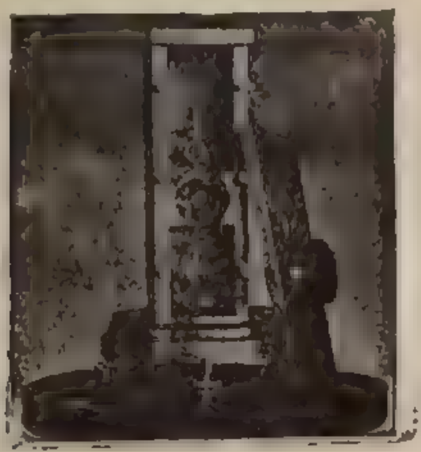


Fig. 1.—Dynamometer.

The first real representation of an alternating-current curve was made by Joubert, who employed a contact piece rotating with the armature of a dynamo, touching a fixed brush at a point of the revolution determined by the position of the brush with relation to the dynamo poles. He obtained a curve for current which was approximately a sine curve. Later, in 1888, Messrs. Wilkes, Hutchinson, and myself modified the method to obtain the curves for E.M.F. and current in the primaries and secondaries of induction coils. This modification was used afterward at Cornell, where Prof. Ryan and others made valuable experiments, and it has been more or less generally employed. The principal difficulties lie in the fact that with

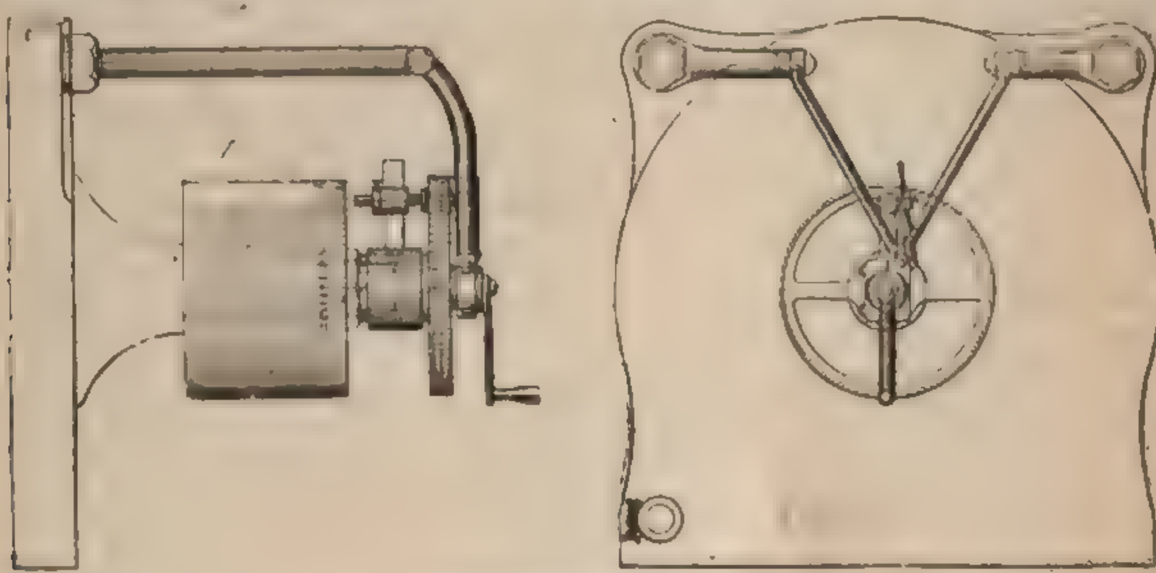


Fig. 2.—Contact Arrangement.

a single commutating arrangement but one curve can be taken at a time, and as an experiment involving four curves takes something like 45 minutes, the condition may seriously change, while the whole voltage of the dynamo is at times on the commutator. It is at best rather a tedious method. In our work referred to above, and in the work at Cornell, E.M.F.'s were measured by an electrometer, and currents were obtained by getting potential differences at the terminals of a non-inductive resistance through which the current passed. Lately, in France, two commutating arrangements have been used to give two curves at once, with a condenser charged through the contact and discharged through a d'Arsonval galvanometer.

By the method which I described last fall, any number of curves may be obtained simultaneously, with only a few volts on the commutator and with a rapidity and accuracy much greater than by the other methods. Briefly, a number of dynamometers are used, equal to the number of simultaneous curves to be obtained. These dynamometers are very cheap and convenient. The first ones used were made by Mr. Carichoff and myself, and were quite satis-

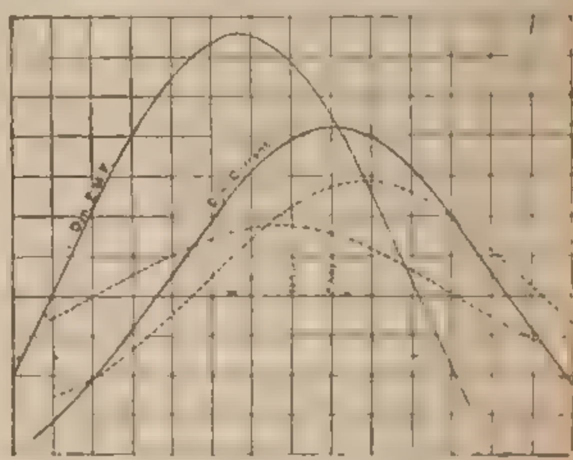


Fig. 3.—Tesla Fan Motor—Period $\frac{1}{140}$.

factory; but experience having suggested some improvement, and our time being fully occupied, Messrs. E. S. Ritchie and Sons made four of them, such as are shown in the picture, Fig. 1. I will describe them more minutely below.

The four dynamometers have their stationary coils wound for, say, primary current, primary E.M.F., secondary current and secondary E.M.F. The movable coils are wound with fine wire, and are all connected in series. The E.M.F. instruments are made exceedingly sensitive, so their self-induction may be made a minimum, and in series with them is placed a large non-inductive resistance, the relation of the self-induction and resistance being made such that the former may be neglected. The circuit of the movable coils is through a battery of a few storage cells to a brush, which may be moved by hand through the arc of a circle, and which touches a contact piece on the dynamo shaft once every revolution. The other end of the circuit being joined by a sliding connection with the contact piece, the circuit is closed through the cells and coils for a short period once every revolution. The instant of closing this circuit is determined by the position of the movable brush with respect to the dynamo poles. Now suppose an alternating current is sent through the stationary coil of one of the dynamometers. If an instantaneous current be sent through the movable coil,

an impulse will be given it dependent on the value of its current and on the instantaneous value of the current in the stationary coil. As the period of the coil is great compared with the period of the dynamo, we will get a steady deflection dependent on this product. If now we move our contact brush, the instantaneous current will pass at some other point on the alternating-current wave, and our deflection will be proportional to the value of the current at this point. By moving the brush through an angle corresponding to a complete wave we can plot the wave exactly, providing we have properly calibrated our dynamometer.

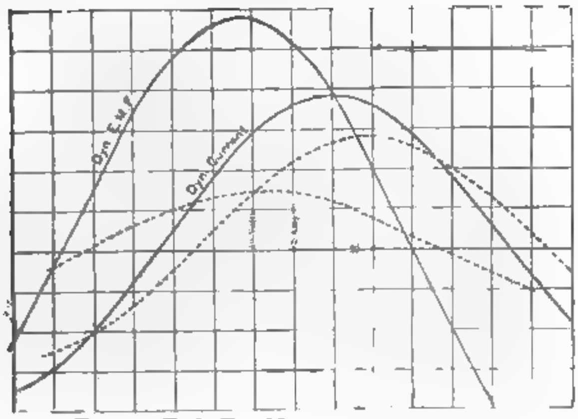


FIG. 4.—Tesla Fan Motor, held—Period $\frac{1}{133}$.

It is apparent that in order to attain accuracy, our instantaneous current must be very brief and very steady, and its value must be the same in actual work as in calibrating. A d'Arsonval galvanometer in the circuit allows us to judge the two last points, and we found that when a high resistance was used in the circuit, so that any variation in the contact resistance was eliminated, almost absolute steadiness was obtained. It was also assured by using a condenser charged during part of the revolution and then discharged by the contact brush through the circuit. To give an idea of the current in this circuit, an ordinary arrangement, when the condenser was not used, was 12 volts through 1,000 ohms, and it must be remembered that this current only passes an exceedingly small part of the time.

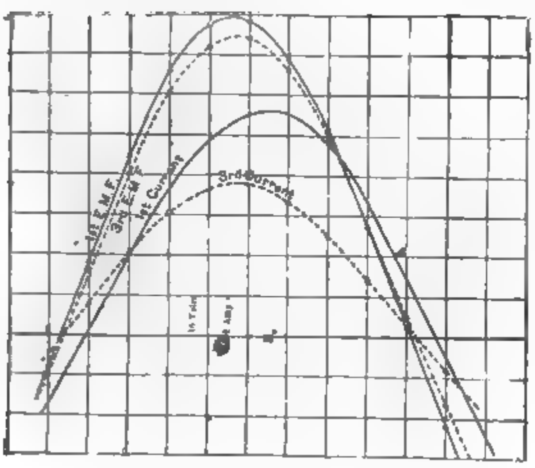


FIG. 5.

Dynamometers.—The dynamometers were made of wood mounted on a revolving base, so they could be adjusted with respect to the meridan. It will be seen on looking at the picture, Fig. 1, that one side is made removable to facilitate adjustments. The fixed-coils are wound in two cylinders, which move in and out through holes in the sides, and whose distance apart is adjusted when the instrument is calibrated, so the scale divisions read directly in volts or amperes, or fractions of them. The movable coil is suspended by a silk fibre, which gives it no directive force, but which sustains it. Directive force is given the coil, and current is introduced to it through two palladium hair springs, which are fastened to stiff brass wires, which serve as the axis of the coil. A vane in a beaker filled with glycerine damps the swinging and makes the instrument absolutely aperiodic. I have rarely used instruments which give more satisfactory results—the zero is invariable, readings may be taken with great ease and rapidity, while a reversal of the current gives equal readings on the two sides of the zero. To show the rapidity of the readings, six curves, representing different quantities in a step-up-and-down transmission were taken in a little over five minutes, and in this case two instruments were used for four curves—those at the sending and receiving ends of the plant—and, therefore, had to be switched from one side to the other at every reading. Twenty points were usually taken for each wave. The curves could, of course, be

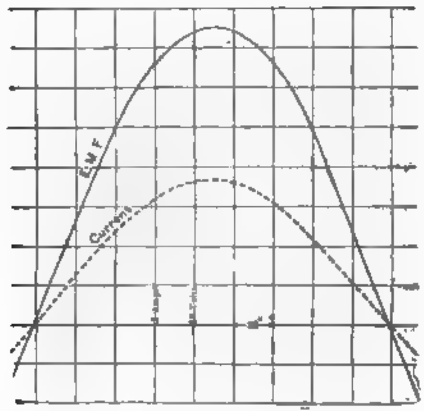


FIG. 6.—Dynamo Direct on Lamps.

photographed instead of observed, but the latter is so much simpler and more satisfactory that—especially in a laboratory where there are plenty of observers—I much prefer it.

Contact Arrangement.—This is shown in Fig. 2. As it comes outside the belt, and as it was often necessary to remove the latter, the swinging arrangement shown was designed and constructed by the Messrs. Hutton. On the shaft was a hard rubber cylinder, with the brass contact almost flush with its surface. The whole arrangement worked admirably. The results of our work will have to be another story. I will simply give a few to illustrate the method.

We have a small Tesla fan motor, intended to work on an ordinary incandescent circuit. There are eight poles, the alternate ones having their windings in different circuits, one set of poles having a few turns of coarse wire, the others having a greater number of fine wire turns. The curves in Fig. 3 show the condition of affairs when the

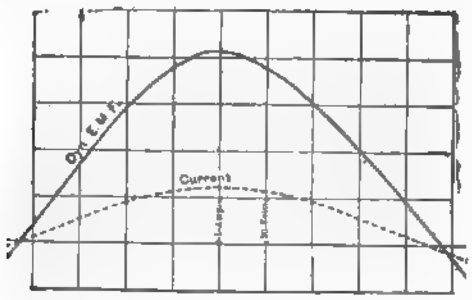


FIG. 7.—Copper Condenser with Coils. Cap. 1·35 M.F's. Wire Core.

motor was working; in Fig. 4, where the armature was held. In the same case, the energy represented corresponds, of course, only to the losses. It seems to be the general impression, by the way, that a rotating field motor starts up with the same torque as a corresponding continuous-current machine. I have shown, however, that a two-phase motor corresponds exactly to a converter—or rather two converters—in which the secondary has an outside resistance of $\frac{p^1}{p - p^1}$, where p^1 is the angular velocity of the armature and p that of the field. When p^1 is 0—that is, when the motor is at rest—it will be seen that the current is in the worst possible condition for starting, and the torque for a given current is small. It is like starting a continuous-current motor with the brushes almost 90deg. from the proper position.

But most of our work has been with circuits in which both self-induction and capacity have been introduced. It is a well-known fact that circuits carrying alternating currents may be given the same period of vibration as the current, or, to put it another way, circuits may be so arranged that with currents of a given period the sum of the energies stored up in the circuit and given out by it is zero. With a condenser and self-induction properly adjusted, if

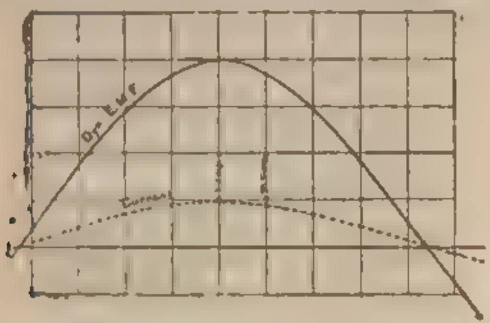


FIG. 8.—Tinfoil Condenser with Coils. Cap. 1·33 M.F.'s. Wire Cores.

energy from the current is being stored up in the condenser, an equal quantity is being given to the current by virtue of the self-induction. That is, we can neutralise our self-induction by a capacity. I can hardly think of any fact more likely to play an important part in the future of alternating-current work. For instance, if a circuit has in it a periodic current consisting of a number of sine curves of different periods—one-third, one-fifth, one-

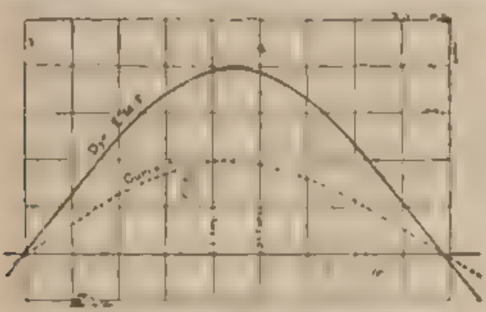


FIG. 9.—Tinfoil in Parallel with Copper. Condenser with Coils. Cap. 2,675 M F.'s. Wire Core.

seventh, etc., the period of the fundamental wave; then if we put in inductive relation to this circuit another circuit whose period is, say, one-third that of the fundamental wave, this current will pick out the one-third period waves in the primary.

An ordinary sine curve E.M.F. may be made to give a periodic current wave with these higher harmonics in several ways—by having in the circuit a self-induction coil whose iron core is saturated when the current nears a maximum, or by using the same coil with a capacity which

FIG. 10.—Tinfoil in Parallel with Copper Condenser with Coils.

neutralises one of the values of the varying self-induction; so we can produce these higher harmonics, and we can pick them out. But it is a complex subject not to be treated here. In all such experiments, however, there are several points which must be carefully attended to, or there will be very unsatisfactory results. If the iron core of the induction coil—provided such a core is used—is not properly laminated and annealed, or if there are considerable losses in the condenser the results will be disappointing. Take the case, for example, where there are eddy currents in the core and there is loss in the condenser. The first effect corresponds to a short-circuited secondary near the coil; the loss in the dielectric of the condenser means that energy is taken from the current, and this energy must be represented by the product of the current into the E.M.F., e corresponding to a transfer of energy, or it is $e\,i$. The

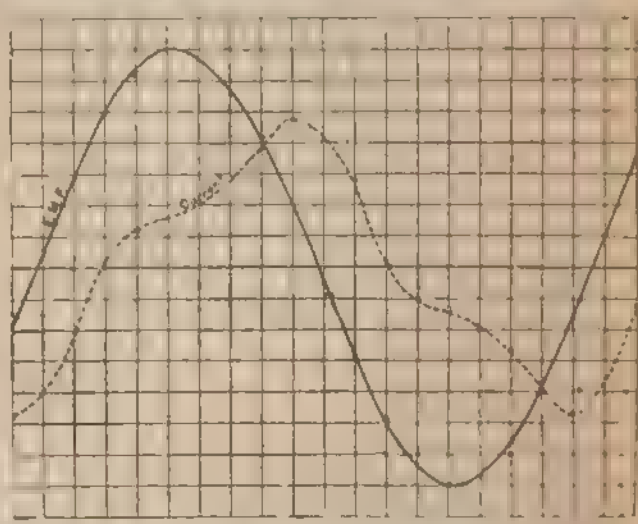


FIG. 11.—Siemens Dynamo on Transformer. Secondary Open Curves taken with Experimental Dynamometers.

value of e is a maximum when the displacement is greatest—that is, when the current is greatest—and for a given current and dielectric varies as $\frac{1}{c}$. If we represent these effects by a revolving diagram as is ordinarily done, and suppose we have neutralised the self-induction by a capacity, we get something like the figure, Fig. 12. The result is that relation between R I and E instead of being 1 to 1, as would be the case were there no disturbing causes, is 1 to 1 +. That is, for a given E.M.F. the current is less than it should be, and a glance at the figure will show that it is thrown ahead of the E.M.F. No possible change in our self-induction and capacity can remedy this decrease in the current, although we may, of course, make the phase angle zero if we wish.

An excellent way to make an iron core, by the way, is to shellac fine, well annealed wires, spread them along a

FIG. 12.

piece of thin paper, brush them over with shellac and then roll the mat so formed into a cylinder. The losses in a condenser are usually small. They are discussed in a paper of Messrs. Hutin and Leblanc, published last spring in *La Lumière Electrique*. We find, however, that if the condenser is made of very thin tinfoil and has a large area, then for heavy currents it may considerably decrease in capacity and offer a definite resistance to the current.

The curves given have been selected almost at random from a mass of data. We have not the time to discuss the results, which are hardly within the scope of this paper. Fig. 5 gives the curves at the two ends of a transmission plant where the voltage was raised from 50 to 1,000 volts and reduced again. Fig. 6 gives the curves for the dynamo directly on the same lamps. It is seen that the transmission decreases the E.M.F. and current, and increases the lag of the dynamo current.

Figs 7, 8, 9, and 10 give curves taken from the dynamo circuit when self induction and capacities were inserted. In Fig. 7 the core of the induction coil was only fairly well laminated; and a condenser with copper sheets between paraffined paper was used. The maximum current is a little over 1·2 amperes, while it should have been about four amperes if there were no losses in the circuit. The second point of crossing is thrown out by a change of speed of the dynamo. Fig 8 shows the result of substituting a tinfoil condenser of the same capacity in place of the copper one. In Fig. 9 both condensers were used and a considerable part of the wire core was withdrawn. In Fig. 10, with the same two condensers, a solid iron bar was used as the core of the induction coil.

Fig. 11 gives the curves obtained in the circuit of a dynamo connected to a transformer whose secondary circuit was open.

ANTI-FRICTION MATERIALS FOR BEARINGS USED WITHOUT LUBRICANTS.*

BY KILLINGWORTH HEDGES, M.I.C.E.

The use of oil as a lubricant in machines is to separate the rubbing parts and to diminish the friction of metal upon metal by an intervening film of the lubricant.

If the oil is supplied in sufficient quantity to cause the entire separation of the metals, the friction may be reduced to a measure of the viscidity of the unguent used; where oil is furnished in less quantity, then the friction of metal upon metal is usually resistance due to interlocking particles of the revolving and stationary parts, the oil used under this condition finding its way from the bearing loaded with the metal that is gradually torn from either the revolving shaft or the bearing in which it has worked. It is a well-known fact that heavy lubricants effect a better separation of the metals than those that are more limpid, although the power required to slide the surfaces one upon the other is much less with the latter than with the former, but at the same time the wear and tear of the metal may be greater. It has been stated by more than one authority that it makes little difference what metal is used for the bearing of a revolving shaft provided oil in sufficient quantity can be introduced, so as to separate the shaft from the bearing in which it revolves; this is proved by the success which attends the use of cast iron for the bearings of ordinary shafting, it being no unusual occurrence to find the cast-iron sleeve of an adjustable hanger showing the tool marks after running several years with an excess of lubrication. Such a bearing would, however, quickly seize if the oiling was neglected, and therefore the friction may be said to vary according to the attention paid to the oiling. For very low pressures, amounting to only a few pounds on the square inch on the rubbing surfaces, oil causes a loss of power, so to make it advisable wherever possible to dispense with it altogether; Prof Coleman Sellers even goes further than this and states that even when the pressure on the rubbing surfaces is less than 50lb. per square inch, the viscidity of the unguent acts as a sensible retardent.

Engineers have for a long time been looking for a material capable of being used for bearing surfaces, and having a low coefficient of friction when worked dry and without any oil. The idea is not one of recent date only, but may be said to go back to the time of the Romans, as some of the hand flour mills found at Pompeii have the lower stone fitted with an iron bearing which evidently worked dry in the stone socket of the upper stone. The celebrated Coulomb experimented with an iron axle moving in a bush of elm: the friction was stated to be "one-twentieth of the force of pressure;" he also made numerous experiments with wood axles slightly smeared with tallow, and also recommended the use of blacklead; the material he found to give the best results was green oak on elm, and I believe the wooden axles of the waggons which are used in Derbyshire at the present time to transport the heavy grindstones from the quarries, are constructed with axles of oak in a similar manner; throughout Egypt, in the Nubian waterwheels, which are everywhere employed for irrigation, unlubricated wooden bearings are used, which appear to wear very slowly, the surface of the bearing acquiring a fine glaze. Stone bearings have also been employed for shafts; according to Rankine, the natural stones fit for this purpose are those which are wholly free from grittiness, and are somewhat inferior in hardness to iron, such as gypsum, pure clay slate, compact limestone, marble, and silicate of magnesia; from the latter the substance called "adamas" was made by calcining the magnesia, grinding and moulding it by hydraulic pressure into blocks, which were then baked.

In addition to these oilless bearings there are others in which perhaps a small quantity of grease might have been employed, such as the leather bushes used in spinning wheels, and which we are familiar with on that part of the oar which works in the rowlock. Glass has also been tried, but the only kind which has survived to the present and has been the most successful of all is the plumbago bearing. The author has been told by the old millwrights that this material was often used as the footstep bearing of the upright shafts in water mills, and most of us have seen plumbago employed instead of tallow for lubricating wooden bearings, and there is the familiar example of the carpenter's screw. The first adaption of plumbago in a more practical form was the invention of Gordon, who inserted a number of moulded plumbago plugs in the standard size axle-box of an ordinary carriage wheel. It is said that the vehicles ran successfully without any lubricant.

Graphite or plumbago is the principal ingredient in numerous inventions for dry bearings, many of which have not got further than the Patent Office; it has been mixed with pulverised iron, asbestos, vegetable fibre, paper pulp, blood, and in one curious adaption sponge is used. In nearly all these applications the anti-friction composition is packed into suitable grooves, which are used in the bearing, very much in the same way as asbestos is used in cocks. A substance which has been termed "metalline," which, although it contains graphite, appears to be composed of finely-divided lead, has been rather extensively employed. The chief disadvantages were the expense due to the way the material was used in the form of little plugs let into drilled holes, and the necessity for oiling when the plugs were worn sufficiently to cause contact between the metallic surfaces, thereby changing the character of the bearing.

The latest form of dry bearing is of solid material, which can either be moulded so as to fit any plumber's block, or can be tooled or worked in the same manner as an ordinary brass. A new material for this kind of bearing has been recently tried in the United States, and consists of finely-ground plumbago, mixed with wood fibre in a moist condition, and pressed into a mould of proper form; it is then saturated with some drying oil, and oxidised in hot dry air. This bearing has been favourably reported on by the committee of the Franklin Institute, and a shop has been fitted up complete, so that the whole of the machinery, including the steam engine, runs without any lubrication at all. The report, which may be taken to apply to dry bearings generally, states "that an invention of this kind, by diminishing the use of lubricants, diminishes the cost of machine construction, by doing away with the many devices incident to oil—oil cups, oil-hole covers, the oil-holes themselves, which have to be carefully placed, oil tubes to lead the lubricants to the inaccessible parts of machinery, as well as the cost of the personal attention and the cost of the lubricant required to keep the machinery in perfect order."

My own investigations of a suitable material for an oilless bearing began with the use of plumbago, which was moulded so as to form a circular bush, but this was soon discovered to be a failure on account of its rapid wear. I then constructed bearings of ordinary carbon, such as is

* Paper read before the British Association at Edinburgh.

used in batteries, and for producing the electric light by means of the voltaic arc. The first experiment was made with the bearings of a small dynamo, which ran for a considerable time, but the drawback of using carbon was mainly on account of the impurities which it often contained. A small amount of silica in the carbon was found to cut the shaft very badly, whilst if soft carbon was used the wear was as rapid as with plumbago. In order to lessen the cutting action and the friction, finely powdered steatite was mixed with the carbon, and henceforth no difficulty was experienced, even when the load was unequally distributed on the bearing. The name of carboid has been given to this mixture, its specific gravity being 1·66, that of carbon, as used in arc lamps, being about 1·68; therefore carboid is about one-fifth the weight of brass, it can be moulded with the same ease as carbon, and can be turned, bored, or shaped to any desired form. In practice it is found that the cylinders, as they leave the dies, are quite true enough to be put into bearings without any tooling, although it is preferable to run for a short time with half the load, and then remove and scrape the bearing so as to equalise the surface of contact.

Friction as compared with Lubricated Bearings.

Prof. Sellers, writing on the Franklin Institute report, states that "the coefficient of friction is lower with the dry bearings experimented on than that of many oiled bearings in good condition, and that it is undoubtedly lower than with metal bearings, as usually operated with moderate attention and poor qualities of oil. It seems to be constant in its frictional resistance, whether warm or cold, while it does not run lighter when worn by use, as some oiled bearings do. Its uniform action is better than many oiled bearings and very much safer; the constant amount of frictional resistance being known, can be provided for in the power of the machine."

The above agrees in the main with Prof. Unwin's experimental results with carboid. A bearing, 1¼in diameter by 2½in. long, cut in halves, was recently tested under loads varying from 100lb. to 1,800lb., or about 15lb. to 170lb. on the square inch, at speeds from 110 to 490 revolutions per minute, the period of test extending over six days, during which it was kept almost constantly running without any lubrication or attention.

Summarising the experiments, it appears: 1. That the coefficient of friction is almost the same, and has not diminished as the carboid became worn to a better bearing surface. 2. That the coefficient of friction increased as the temperature increased during the run, but is practically the same for any increase of pressure, and diminished with increase of speed, the maximum number of revolutions per minute being 490. 3. That no injury is caused to the shaft even if the bearing gets very hot, as it was found to be impossible to make it seize.

The trials were made in one of Prof. R. H. Smith's new design of testing machine, in which there is no bending pressure upon the journal at all, the load being adjusted by the compression of a spiral spring, which presses upon both halves of the bearing with equal force. The heat generated by this form of machine is twice as much as that in which the load is applied to one step only, and this to a certain extent limited the pressure to which the bearing was subjected, and the experiments with greater pressures will have to be completed with another design of holder, so arranged that the heat generated has a better means of escape.

The conclusion arrived at by the author with regard to dry bearings is that the conductivity of the shaft and the holder or support of the bearing; if this was arranged that any heat generated is dispersed, the coefficient of friction will not exceed that of a lubricated bearing.

First Costs.—If the bearing works under such conditions that any heat generated at starting a new bearing may readily be conducted away, the first cost of a dry bearing will be less than any form of brass, but taking the case of a dynamo bearing where any excess heat might be disadvantageous, it will be necessary to carefully true the bearing by scraping so as to fit the shaft, and under certain conditions where there is a great pull on the belt, it may be necessary to keep the bearing cool by means of a circulating flow of water.

Economy of Working.—This is very marked; besides the cost of the lubricants used in large establishments, there is also the attention required to apply the oil and keep the parts clean. In laundries and in other trades where unskilled labour is employed, the danger of oiling machinery in motion is very great; besides this there are instances where the lubricant used is in itself a source of danger, such as the risk of oil waste taking fire by spontaneous combustion, and the drip from bearings certainly renders the floors of mills highly inflammable.

The principal application of carboid up to the present time has been for the bearings of ordinary shafting, and for bushing loose pulleys; it has also been applied for the bearings of steam-heated rolls such as are used in cloth mills and paper works. The result of two years' experience and many experiments with light trucks seems to point out the desirability of extending its use to the axle boxes of tramcars, and perhaps railways generally, as it involves no change in the axle-boxes; even the existing brass can remain and be faced with carboid, which material can be cemented to either a smooth or rough surface.

Exhibits.

The bearing used in Prof. Unwin's experiments after six days' running.

Carboid blocks similar to those used for the wire-rope tramways in Edinburgh.

Two-inch carboid bush taken from shaft after a year's constant use.

ON THE CLARK CELL.*

BY DR. KAHLE.

In connection with the report of Prof. Glazebrook, I beg to call your attention to some researches I made, by order of the Physico-Technic Institute at Berlin, on Clark cells. The time is too short for communicating my measuring methods and results in full extent; I can only give you a short summary of the chief points.

I used in my researches Lord Rayleigh's H form, the positive electrode being mercury once distilled, the negative an amalgam containing 90 parts of mercury and 10 parts of zinc. The last was filled in the vessel as a hot liquid, and solidified on the bottom. The paste, which covers the positive electrode, is made by grinding together mercurous sulphate, mercury, and a mixture of crystals and concentrated solution of zinc sulphate. No heat was used in preparing this paste. The mercurous sulphate was bought, and contained, according to chemical analysis, no foreign ingredients. The zinc sulphate was made basic by boiling with rods of metallic zinc; after cooling, the dissolved oxide of zinc precipitates, and with it the oxides of the metals more negative than zinc. For oxidising the ferrous sulphate, which is always present in commercial zinc sulphate, a small current was sent between two platinum electrodes through the boiling basic solution; the ferrous sulphate was changed by the generated oxygen into ferric oxide, and fell out. The H cells set up with these materials showed a great agreement in their E.M.F.'s, I never found a difference greater than $\frac{1}{10000}$th of a volt between the E.M.F. of any two of them.

The next point I studied was the influence of the impurities in the different materials composing the cell on the E.M.F., because on the one side it is well known that the smallest impurity of the mercury alters very distinctly the E.M.F., and on the other side the mercurous sulphate I bought never contained impurities of a remarkable amount, and different samples always had the same qualities; I only investigated, as the most important matter, the impurities of the zinc and its sulphate. It was found that the foreign ingredients of the zinc sulphate are of very little importance, and that only the presence of free acid in the above described cleaning process, the result of boiling with metallic zinc, alters the E.M.F. in a considerable degree. Among the impurities of the zinc only those caused by metals more positive than zinc are of importance; the zinc may contain considerable quantities of the negative metals without any alteration of the E.M.F. I suppose the impurities of the zinc are of greater importance. If we use

* Paper read before the British Association at Edinburgh.

it in the form of rods amalgamated on the surface, it seems to be a great advantage to dissolve the zinc in mercury, using it then as a solid amalgam.

The following are the values I found by a great deal of observations for the temperature coefficient of different forms of cells, measuring between 10deg. and 30deg. in rising and decreasing temperature. The figures here given are the mean values of some cells of the same form, treated in the same manner.

Form of the cell.	Temperature coefficient.	Mean difference between calculated and observed values of E.M.F.	Mean difference between the E.M.F. of the different cells and that of the mean of several H cells used as standards.
		The unit being $\frac{1}{10000}$ths of a volt.	
H cell set up in Lord Rayleigh's manner.	+0·000812+0·000013 (+ − 15)	12	+ 3
H cell, the paste covering both electrodes.	+0·000774+0·000020 (+ − 15)	12	+ 7
A new form for researching purposes, the paste covering both electrodes.	+0·000791+0·000017 (+ − 15)	9	+ 9
The cell issued hitherto by the German Reichsanstalt.	−0·000806+0·000006 (+ − 15)	30	− 29

The mean value of the temperature coefficient, therefore, would be

0·000796+0·000014 (+ − 15).

Lord Rayleigh has given the following values for the two different cells he investigated:

+0·000827+0·000018 (+ − 15)
+0·000740+0·000016 (+ − 15)

the mean being

+0·000783+0·000017 (+ − 15).

I suppose, for practical purposes, the value found by Lord Rayleigh and by me are identical.

The most important matter is to obtain the absolute term of the E.M.F. For the purpose I used a measuring arrangement similar to Lord Rayleigh's. The current, which produces on the terminals of a known resistance a pressure equal to that of the Clark cell, was obtained by the silver voltameter. It was found that the same current deposits the more silver the more oxide of silver is dissolved in the solution of the nitrate. I made a solution of nitrate crystals, and boiled a part of it a long time with oxide of silver; the deposit gained with this basic solution was about $\frac{5}{10000}$ths greater than that with the original solution. Therefore, using a certain number for the equivalent of silver, there will be a little uncertainty of some parts of 10,000 in measuring currents by the deposit of silver. Now, as first shown by Prof. Schuster, and also proved by me by a good deal of experiments, the deposit, when the voltameter is in vacuo, is about four parts of 10,000 greater than in ordinary air. But the absolute value of the E.M.F. is not touched by this fact, because making the electrolysis in this manner one has certainly to take a greater figure for the equivalent, and therefore the ratio between the unit and the measured amount of current remains the same. The following figures are given by taking one ohm = 1·063 S.U., and by assuming that a current of one ampere strength deposits in an hour 4·0259 amperes; the last figure exceeds that given by the Board of Trade only by six parts of 100,000. I found by some 30 experiments, the E.M.F. of the H-cells, set up with clean materials in the above-described manner, as 1·4332 volts at 15deg., and am sure that, when using the same arrangement of the silver voltameter, this value will be right by five parts in 10,000 if the equivalent is sure in this limit. If I express the value given by Lord Rayleigh for the cells of the original Clark's form in this unit, it is 1·4346 volts at 15deg. Lord Rayleigh finds the E.M.F. of this H cell a few ten thousandths of a volt greater than that of the old form. Therefore it would, perhaps, be 1·4350 volts at 15deg.

Recently, Prof. Glazebrook has made a new determination, and finds in the above fixed units as E.M.F. of the original Clark cell, 1·4312 volts at 15deg. He has also compared H cells set up by me and now brought to England, and finds their E.M.F. by $\frac{4}{10000}$ths of a volt smaller than that of the original form. Therefore, the E.M.F. of the H-cell is 1·4338 volts at 15deg. This last value and that found by me are in good agreement. It is remarkable that the anodes and cathodes in my voltameters are much smaller than those in the English ones.

It may be mentioned here that the mean E.M.F. of four H cells set up in the same manner as before, but containing, in accord with Prof. Carhart's directions, a solution of sulphate of zinc, saturated at 0deg., was found as 1·442 volts at 15deg., using the same units as above.

It only remains to give some directions on the best form of Clark cells. I suppose it will be good to distinguish such cells which shall remain as standards in the laboratories and are used by their manufacturer, and such ones which shall be used for practical purposes. These do not need to have the same degree of accuracy, but they must be able to be carried about. In the Board of Trade's memorandum, the original Clark cell is adopted as the standard, but I suppose Lord Rayleigh's H-form gives more accuracy and is easier to set up. In the old form, not all the parts of the zinc rod are in saturated solution, and therefore the value of the E.M.F. will be a little uncertain. Another disadvantage is, that parts of the zinc rod may fall down in the mercury, and will so produce a considerable changement of the E.M.F. On the other hand, the electrodes of the H-form are always in concentrated solution, and there is no possibility of parts of the negative electrode coming over to the positive one. I have set up about 60 H-cells, and have found no difficulty, when using carefully cleaned materials, to keep the difference of the E.M.F. of the single cells under a ten thousandth of a volt.

To construct cells for practical purposes which will stand carriage, the most simple way is to separate the two electrodes by a porous wall. I can show here such a cell of a form constructed by Dr. Feussner and issued hitherto by the German Reichsanstalt. The positive electrode is an amalgamated platinum plate with the surrounding paste in a porous vessel of clay. The zinc rod forming the positive electrode is on the upper part protected by a glass tube; the lower part is blown rectangularly and covered with crystals of sulphate of zinc. The whole glass vessel is filled with a concentrated solution of this salt. The E.M.F. of such cells is about $\frac{3}{10000}$ths of a volt higher than that of the H-cells. The agreement of different cells of this form is very sufficient for practical purposes; the difference between the E.M.F. is always smaller than $\frac{1}{1000}$th of a volt. The only disadvantage of this form is, that its E.M.F. does not follow quickly the alterations of temperature; but I suppose one could improve that by diminishing the size of the cell.

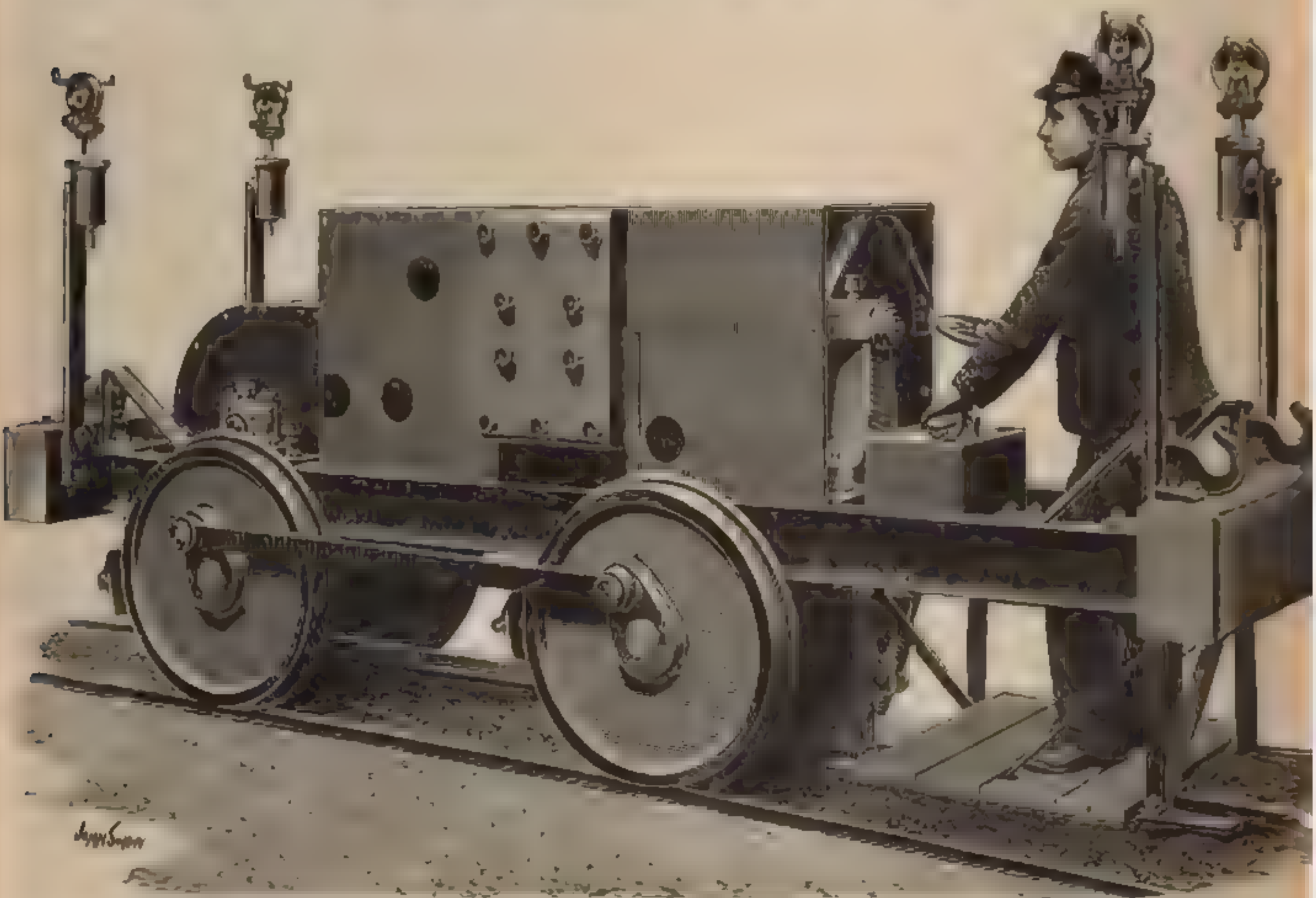
We endeavoured in the Reichsanstalt to get transportable Lord Rayleigh's H form on account of its good qualities, and to do this without introducing foreign substances as porous walls. The investigations in this direction are not yet finished, but I can show you here a cell which was constructed for this purpose and seems to be good. The positive electrode is formed by an amalgamated platinum plate fixed on a wire of the same metal, which is melted in the bottom of one of the two tubes forming the vessel. The negative electrode is formed by the 10 percentage zinc amalgam solidified on the bottom of the other tube, and also connected with a platinum wire melted in the glass. The whole vessel is filled with the paste and closed by a glass stopper perforated by a thermometer, of which the bulb is within the vessel. Such a cell can be turned

without any danger and is suitable for transport. The E.M.F. is about $\frac{1}{10000}$th of a volt smaller than that of the H cells; the agreement between the E.M.F.'s of different cells constructed in similar manner does not exceed $\frac{5}{10000}$ths of a volt. But before using such cells for practical purposes they must be observed for a longer time till one is sure that their behaviour will not be altered by age.

These are the principal results gained during the last time in the Reichsanstalt on this matter. Some of them will be already known here, but I hope to have given new proof that the Clark cell is a very accurate standard for E.M.F. and a good measuring instrument for practical purposes.

AN ELECTRIC LOCOMOTIVE.

The accompanying illustration represents an electrical locomotive recently made by the General Electric Power and Traction Company, Limited, of 35, New Broad-street, E.C., at their Kentish Town Works, and is part of a large installation supplied to the Greenside Mining Company,



Cumberland. The locomotive is for mining work underground, the road on which it runs being in some places as narrow as 32in., the gauge of rails being 22in. It was found impossible in the small space available to place the motor across the frame with its shaft parallel to the axles, so it was arranged parallel to the rails. Three reductions of gearing are employed, one necessarily being through bevel gearing. The whole framework of the machine is hinged from the driving axle, which is made exceptionally strong for the purpose; the weight on the other wheels being taken through strong spiral springs on the top of gunmetal axle brasses.

The design of the "Immisch" motor, as shown, was chosen owing to the protection afforded to the field windings by this type of machine. The motor is series wound for a difference of potential of 200 volts, and develops 15 brake horse power, at 1,000 revolutions per minute. The length of the road is 1,200 yards, and the current is collected from two bare copper wires carried on insulators overhead. The E.M.F. is reduced from 500 volts to 200 volts by means of a motor transformer placed at one end of the line. The whole installation is rendered doubly interesting from the fact that a copious natural supply of water on the side of a hill is utilised as a prime source of power to drive a large Vortex turbine, the water being conveyed down the hill through 15in. pipes. A building has been erected on the hillside of this wild-looking country, in which the turbine drives an "Immisch" four-pole dynamo, which develops 100 e.h.p. at about 600 revolutions per minute. The dynamo is compound wound, with a working difference of potential of 600 volts, and supplies current also for motors driving pumping and winding plants, besides lighting the colliery both above and below ground.

THE DEVELOPMENT OF THE TELEPHONE.

The Duke of Marlborough writes to the *Times* as follows:

You have on several occasions done me the favour of inserting letters on the question of the development of the telephone in this country, and I venture to make one more appeal for space in your columns for a few further remarks on this subject.

There seems to be a misconception in certain quarters of the Press that the arrangements which have been come to between the two great telephone companies, as the result of their mutual agreement, are not likely to bear any immediate useful fruits in the public interest. It will not be long before this misconception is cleared up by the efforts which these companies are about to make to introduce, not only in the metropolis, but also in all the other large towns of England, a system of telephony more perfect even than any which exists in other European countries. The public have been led to suppose that the competition of these two companies among themselves might have produced this result in a more satisfactory manner since competition must have led to rate cutting between these two rivals in this industry. A little consideration of the matter would, however, show that, though a lower scale of

charge might have been produced by competition, the eventual cost to the public and also to the shareholders would have been considerably greater. I need not instance the disastrous effect of rate cutting and competition generally, as they must be very well known. We have some notorious instances of the waste of capital and the cost to shareholders of rate-cutting enterprises in the matter of American railways, and with regard to the telephone the consequences would have been even more disastrous. The establishment of two completely independent rival systems of telephony, say, in the metropolis, would mean that when the amalgamation eventually took place on the surrender of one of the rivals the victor would become possessed of a system which would be no earthly use to amalgamate electrically with the other. The whole system would thus be crystallised into a bad system of distribution which could not be altered, and the public would therefore be, electrically speaking, inefficiently served.

As to the cost to shareholders of a competition, that speaks for itself; and, as to subscribers, though they might appear to have the advantage of lower rates, they would have great inefficiency, and they would also be compelled to pay two telephone subscriptions instead of one and have two sets of instruments in their business premises or homes. All this will now be avoided by the working arrangement that has been come to between the two telephone companies. The area of England is so large that the demand for capital expenditure will be so great that the apportionment out of areas should present no insuperable difficulty to the respective companies. As to commercial arrangements there is no reason to see that these should present any insuperable obstacle to a harmonious scheme of development, considering the fact that both companies are in harmony with the General Post Office, and are willing and ready to assist in the development of the great trunk system and inter-trunk connection throughout the country which the Government is commencing. It is not at all improbable that the demand for the use of the telephone throughout this country will increase to an extent little anticipated, and that in the course of a very few years instead of 40,000 subscribers, as there are at present, the number will reach nearer 200,000, owing to the demand which will be created to speak over the Government trunk systems. We have as yet had no experience of the use of the telephone in England, but with the knowledge which is at present possessed by electricians in this country and abroad the two companies are now in a position, acting together on a settled plan, to establish systems of distribution on the twin-wire principle throughout the large towns of England, which will practically result in the establishment of a new industry. By the Act which was passed last session, the Government taking all the receipts on these trunk lines, the profits of distribution alone are left to the companies. The organisation, however, which it represents to carry out this work efficiently is enormous, and would require the creation of a new public department if the country were to ever undertake the working of the system itself.

As to the matter of rates this question produces some difficulty to determine at present, owing to the Government having established a system of telephone areas which will necessitate sound consideration on the part of the companies before establishing their new scale of charge. The first requirement to be met is undoubtedly efficiency. This applies not only to private service to subscribers' houses, but also with regard to the connections which are now to be made with the post offices throughout the country and the establishment of call offices, which should be located in every town in all convenient situations. In the matter of price it must be remembered that there will be great disadvantage in having the rate so low that the demand would become larger than it would be possible to meet conveniently from an electrical point of view. If every householder throughout the country possessed a telephone the amount of unnecessary talking which would take place is somewhat inconceivable, and in some ways it is better that the price should be one which should have some relation to the purposes of the user. For the general convenience of the public call offices should be largely multiplied, so that no one should be deprived from the use of the telephone from the charge being too high for a private instrument.

I observe in your to-day's issue the publication of the statistics of the telephone companies in the United States, from which it appears that the number of subscribers has grown between 1880 and 1890 from 48,414 to 227,357, and that the net earnings in the year 1890 from this industry represent 5,260,712dol. on a capital expenditure of 14,605,787dol. With regard to Sweden, which is probably the European country which has developed the telephone business more completely than any other, the system of Government trunks and local exchanges has arrived at a wonderful state of development. From what I have seen of the working of the telephone in that country the facility with which persons in one town converse with those in another is quite remarkable. The subscriber calls up the Stockholm exchange, say, and requests to have a conversation arranged with either Malmö or Gottenburg. The trunk operators communicate together by comparing the lists of persons who have appointments, and the operator at Stockholm telephones back to the subscriber the hour at which the conversation required has been negotiated. In the busy time of the day it may take some two or three hours before the conversation can take place, at other times half-an-hour is sufficient, and even less. It is easy, therefore, to see, when this system is properly applied in England by the action which will now be taken up by the General Post Office in laying inter-trunk wires all over the country and by the action of the telephone companies establishing an efficient distribution in all telephone areas, that the development which has taken place in America can be easily equalled by that which must come about in this country in a remarkably short time. England is an ideal country for the development of the telephone. It is inhabited by 36 millions of people, all living in a small area, and there is no town so distantly situated from another that they cannot be put into telephonic communication. The companies have thoroughly realised the situation both from the point of view of the public demand, and from the point of view of electrical knowledge, and it is certain that a new era is about to commence in this important industry which will largely change business relations throughout the country. To be able to hold a conversation of a thoroughly audible character between Glasgow and London may save several letters, telegrams, and also a railway journey. The price at which this boon has to be paid for is no measure of the value to the business man in time and labour. In large cities, such as London, the saving of time and expense in journeys in cabs, in making appointments for interviews, and the sending of letters is often enormous. All this development has been impossible up to now. The facilities which the telephone companies possessed were absolutely insufficient even to carry out a single-wire system in an efficient manner. The powers which the Post Office now possess will be conceded by the department to the telephone companies under certain conditions, and it is confidently believed that these powers will be sufficient to enable the companies to establish underground twin wire systems in all large towns. No doubt, if Parliament would have treated the telephone companies in the same liberal manner that the electric light companies have been treated, there would be less expense and less difficulty in laying the telephone distribution system. It is hoped, however, that these difficulties, which still exist, will be all successfully surmounted, and that before long London will have a telephone system laid underground capable of serving 50,000 subscribers in the metropolis alone; while the other large towns of England will be equally well engineered from the telephonic point of view.

As there seems to have been some misconception in the public mind as to the attitude which the companies have assumed towards one another and also as to the relation of the companies to the scheme which has been formed by the Post Office, I shall be very glad if, by the insertion of this letter, the public may see that the Act which was passed last session regarding the telephone industry and the action of the companies themselves is likely to bear immediate and important fruits.

Major-General Webber, R.E., has also written to the *Times* on the same subject, as follows:

Sir,—Ever since the prospectus of the New Telephone Company came out, on July 29 last, the public interested in the use and progress of telephony in this country have waited patiently for a statement such as the Duke of Marlborough has favoured us with in your issue of this date.

That some such statement was necessary was obvious as soon as it became apparent, by the constitution of the directorate of the Board of that company, that its control must necessarily fall into the hands of the representatives of the National Telephone Company, who occupy half the seats, and whose knowledge and experience of the subject must give their influence a preponderating weight in its deliberations.

May I ask the public, through you, to consider if the letter of the Duke of Marlborough has done anything to dispel the conviction, which has naturally arisen in their minds, that the recent developments can do anything else than perpetuate a great monopoly which the possession of patents in 1880 and their protection since that date created and maintained up till now, to the enormous retardation of the industry and with the result of a telephone service in this country second to none in inefficiency?

The Duke of Marlborough, in his able letters to you last year, was the vehement representative of the expression of the national discontent on the subject. His letter to you, Sir, of yesterday is not the only instance of how easily the assumption of "office" may completely justify what, when "out of office," appeared worthy of every kind of animadversion.

To a large extent his Grace's letter is a repetition of the well-known and oft-repeated advantages to the community of an efficient system of telephone exchange communication and its eminent adaptability to the commercial and domestic wants of this country.

He then proceeds to make wide promises as to the future performances of the "two great telephone companies."

As regards these promises, it may be observed that they are identical with those held out by the Bell and Edison, the United, and the National Telephone Companies in the early part of the last decade, except that to the "two great companies," now practically "one," is left the work of providing for "distributing" what the Government trunk lines will convey from centre to centre.

The Duke, in admitting to you that "we have as yet had no experience of the use of the telephone in England"—a postponement brought about by a monopoly—claims that this new monopoly, the character of which is undisguisable, will confer a great boon on the public, because he proposes to adopt certain electrical arrangements, the advantages of which were, however, nearly as well known to telephone engineers in 1880 as they are now.

Is it to be expected that, even while acting as the handmaid of the Postal Telegraph Department (itself a huge State monopoly), a private undertaking—or two undertakings, practically, under one direction—is likely to become suddenly the benefactor of its customers, as suggested by the Duke, or that there is any hope of its becoming "a system of telephony more perfect even than any which exists in other European countries"?

But in using all the well known arguments in favour of monopoly his Grace has "let the cat out of the bag," but with becoming reserve.

He deprecates all "competition" and "rivalry," as if we in this country of railway and other competition do not know its value when we have to be served well and cheaply. His words with reference to the past are worth quoting. "Though a lower scale of charge might have been produced by competition, the eventual cost to the public and also to the shareholders would have been considerably greater."

Because London has not had the wholesome advantage of this "would have been," it is that we have had (as the Duke states) "no experience of telephony," not only as regards efficiency, but as regards economy of rates.

It would take too much of your space to show how all these "would have beens" can be scattered to the four winds, but I will quote once more what I submit is a most "damning" admission in the letter: "In the matter of price it must be remembered that there will be great disadvantage in having the rates so low that the demand would become larger than it would be possible to meet conveniently from an electrical point of view."

Between the lines only the monopolist will fail to see that the demand for telephone facilities, which, but for monopoly, would long ago have reached vast proportions in this kingdom, is to be regulated, as heretofore, by the facilities which the companies choose to afford and by the charges they select to make.

In 1884, in a paper I read before the Society of Arts, I attempted to describe the vast development of the industry which its adoption into the daily life of the people ought to bring about; I showed how no electrical difficulties lay in the way of practically indefinite extension, how the then subscription of £20 per annum might be easily reduced to £8 for all ordinary demands, and how desirable it was that if any great advantage (the existence of which I deny) was to be obtained by the public from monopoly, it should be in the hands of the State, when the light of public opinion can, at any rate, be brought to bear on the conditions of efficiency and cost.

The spread of the industry I had in view did not exclude "the householder," as the Duke of Marlborough suggests, and did not relegate that individual to the use of a "call" office, nor confine it to a paltry 200,000 subscribers. Nothing since then has occurred to alter the conditions then propounded.

So long as the Duke bravely combated the existing state of things and realised that they were due to the absence of healthy competition, no one more cordially went with him than I did; but there is now no misconception in my mind that the fruits which the monopoly (perpetuated by him) must bear, in spite of the Act under which he attempts to shelter it, will fall far short of what the public has had a right to expect after patiently waiting for more than 12 years for an efficient and cheap telephonic service.

CORNWALL POLYTECHNIC EXHIBITION.

On Tuesday, August 23, the sixtieth annual exhibition of the Royal Cornwall Polytechnic Society, held in the Polytechnic Hall, Falmouth, was duly opened. In the absence of the president, Sir Joseph Pease, Bart., M.P., owing to domestic bereavement, the opening ceremony was performed by Colonel Tremayne. The same evening a highly interesting lecture, entitled "A General View of the Application of Electricity," was given in the large hall by Mr. R. N. Worth, F.G.S.

This year the exhibits seem to be exceptionally varied and highly interesting. All goods shown are divided into 12 sections, which includes mechanics, fine arts, photography, and natural history. This year a successful effort has been made to secure a representative display of electrical goods and appliances. Largely owing to the energy displayed by the secretary, Mr. Edward Kitto, the society may be congratulated on having been the means of bringing together a most comprehensive and complete collection of electrical goods.

Messrs. Veale and Co., electrical engineers, of St. Austell, are showing a number of appliances actuated by electricity. Among the other exhibits at this stand is an electrically driven pump, which is capable of raising 17 gallons of water per minute to a height of 60ft. The motor used is very small, and was specially constructed by Messrs. Veale for this purpose. To work the pump at full power it requires from six to eight amperes, at a pressure of 100 volts. Among other goods shown in action at this stand are electric blowers and fans, and electrically driven screw-cutting lathe, and electrically-heated flat and curling irons, kettles, and other similar domestic appliances similar to those shown by Messrs. Crompton and Co. at the late Crystal Palace Electrical Exhibition. Messrs. Veale, who we understand are Messrs. Crompton's agents for Cornwall, are showing samples of this firm's dynamos, arc lamps, and measuring instruments.

Messrs. Benham and Froud, of London, have a good display of their well known electric light fittings.

The General Electric Company, of London, are showing electrically heated irons and double surface heaters, electric fans, ventilators, motors, and a large assortment of electrical accessories.

The Lithanode and General Electric Company, of Millbank-street, London, S.W., have a good display of Lithanode batteries chiefly of the portable type. At this stand the Stella Lithanode miner's lamp is well represented; they also have a number of portable hand lamps for travelling and other purposes. A complete outfit, including battery, wires, switch, lamp and holder, etc., similar to those now being supplied to the London omnibuses, is being shown in action. In addition to the large Frankland Lithanode cells, as used for installation work, this company have on view brougham electric lamps, medical batteries, and small testing cells.

Mr. W. J. Corse, of Old Town-street, Plymouth, has a good selection of medical batteries, electric cigar lighters, distributing and switchboards, and other electrical apparatus of a similar nature, all of which we understand are his own manufactures.

Mr J Blight, jun, of Falmouth, is showing bells, burglar and fire alarms, telephones, and other electrical signalling apparatus. At this stand may be seen a somewhat novel development of the ordinary tread door alarm. This arrangement appears to be like a doormat, but underneath the carpet are placed a series of laths, somewhat after the fashion of a Venetian blind. Each alternate lath is supplied with fine flat spring contacts placed a distance of about six metres from each other. In each mat there are about 40 separate contacts, any of which may be caused to start an electric bell by simply pressing it. By this simple arrangement it is nearly impossible to enter or leave a room where it is placed without bringing into action the alarm-bell.

The mechanical exhibits are highly interesting. **Messrs. Crossley Bros.**, of Manchester, are showing one of their petroleum gas engines. This machine is used for working an air compressor for actuating rock borers and other similar pneumatic contrivances. The new engine is of the horizontal type, is stated to be 4 h.p. nominal and 10 h.p. indicated, and it only consumes three-quarters of a pint of paraffin oil per horse-power hour. If all that is said about this engine is reliable, there is a great future for it for electric lighting purposes.

Messrs. Weyman and Co., of Guildford, are showing the "Trusty" oil engine, which machine, it is stated, has been specially constructed to consume common oils and paraffins. The makers assert that oils of a specific gravity of 800 and upwards, and whose flash point ranges from 80deg. to 300deg. F., may be safely used with this machine.

Mr W. B. Rogers (Messrs. Crossley Bros.' representative) is daily showing in action a new pneumatic caulking tool of very ingenious construction. The new labour-saving machine, which we understand is now being adopted in most of the large shipbuilding yards in this country, is said to caulk the heaviest class of plates at the rate of 3ft. per minute.

Messrs. Stephens and Son, of Carn Brea, Cornwall, are exhibiting their well known "Climax" rock drills.

Messrs. Gates, of Queen Victoria-street, London, have working a small rock and ore crusher which is driven by a small electromotor.

The following awards have been made:

Silver Medals.

Messrs. Veale and Co., St. Austell.
The Lithanode and General Electric Company, London.
Messrs. Benham and Froud, London.

Bronze Medals.

General Electric Company, London.	R. B. Rogers, Falmouth.
W. H. Perrow, Truro.	W. M. Hodges, London.
	W. H. Corse, Plymouth.

Commended.

Messrs. McGeoch and Co., Glasgow.

COMPANIES' REPORTS.

CITY OF LONDON ELECTRIC LIGHTING COMPANY.

Directors: Sir David L. Salomons, Bart., chairman; the Duke of Marlborough, the Earl of Suffolk and Berkshire, the Hon. Alan Charteris, Joseph Bevan Braithwaite, jun., Edward Lucas, Colonel B. H. Martindale, C.B., Frederick W. Reynolds.

Report of the Directors to be presented to the shareholders at the second annual general meeting of the Company to be held at Winchester House, Old Broad-street, E.C., on Thursday, September 1, 1892, at 2.30 p.m.

The Directors beg to submit their first annual report and statement of accounts for the period ended June 30, 1892. The Board has constantly pressed forward the necessary work, and the progress made is satisfactory. All the provisional orders and contracts are now in the possession of the Company, and the former have received the Royal assent. The Directors have secured on favourable terms the freehold of the Bankside central station, and have entered into an "agreement for a lease" of 90 years for the other central station at Wool Quay. Suitable buildings have been erected for all plant now running. Additional buildings for the machinery on order are in progress, the work for which is being carried on by night and day. Sites for several transformer stations have also been acquired, and the necessary work of construction and equipment is far advanced. Contracts for the full equipment of plant for the generating stations have been entered into under such conditions and specifications as will ensure all material and work being of the highest class and efficiency. There is already installed machinery of a capacity of 700 public arc lamps, and 23,000 8 c.p. glow lamps, including reserve. Additional machinery of a capacity of 56,000 8 c.p. glow lamps is being constructed, part of this is expected to be running by the end of October, and the remainder in the early part of 1893. The arrangements for duly executing this work within the limited time allowed by the contracts formed the subject of serious consideration by the Board. With the object of avoiding the inconvenience to the public inseparable from frequent opening of the same streets, it was decided to lay, at one operation, "ways" sufficient for immediate requirements, together with a number of spare tubes to meet all probable developments of the Company's business. By recent legislation, electrical supply companies are authorised, subject to certain consents, to lease for telephonic purposes any spare tubes they may have. One hundred and eighty-four arc street lamps were in use on June 30. The greater number of lamps contracted for will be in operation by about the middle of September. The final date for completion specified in the contracts is the 5th November, 1892. The demand continues to be exceedingly good. On June 30 signed applications had been received for 32,028 lamps, mostly from the limited area in which current was then available. Of this number 11,800 were connected up. The Directors have endeavoured to make their capital outlay earn revenue at the earliest possible moment, having regard to the proper execution of the work and the provision of adequate reserve power. The result is that a considerable income is already accruing. Public and private lamps installed at 30th June were estimated to be earning at the rate of £11,600 per annum, a figure which is daily increasing. From calculations based on the lamps already connected to the Company's mains, it appears that the consumption of current per lamp installed in City offices, shops, etc., will be much greater than was anticipated. There is every indication that the position of the Company is exceptionally favourable. **Messrs. W. H. Pannell and Co. retire, and, being eligible, offer themselves for re-election.**

Dr. CAPITAL ACCOUNT, JUNE 30, 1892.

	£	s.	d.
Share capital authorised:			
£400,000 in 40,000 ordinary shares of £10 each, and £400,000 in 40,000 preference shares of £10 each	800,000	0	0
Share capital issued:			
36,410 ordinary shares of £10 each	364,100	0	0
Less calls in arrear	1,514	0	0
	362,586	0	0
	£362,586	0	0

Note.—Under existing contracts relating to the equipment of the stations and other works there are further contingent liabilities, which become due only after delivery and final testing of the plant.

Cr.	£	s.	d.
Amount paid to the Pioneer Company under the agreement of 13th July, 1891, for works executed, and other matters	94,000	0	0
Less money unexpended and returned	24,699	14	11
	69,300	5	1
Further expenditure:			
Land and buildings, including law charges incidental to acquisition	37,298	12	5
Plant: Boilers, pumping, feed heating appliances, engines, arc dynamos, alternators, exciters, transformers, accessories, etc.	80,003	11	8
Mains (including cost of laying and repaving) lampposts, lanterns and lamps, etc.	141,672	2	6
Meters and electrical instruments	1,215	18	8
Tools and implements	1,414	8	3
Office furniture	291	16	8
Remuneration of chief engineer and professional charges	6,000	0	
Cost of obtaining the four provisional orders under agreements with the contractors	6,500	0	0
Expenses of trials, running and maintenance of lighting at central stations	4,335	16	5
Directors' remuneration	1,000	0	0
Salaries, rent, rates, insurance, legal and general expenses	5,320	11	6
	£354,953	3	2
Less—sale of current, £2,098 2s.; meter rentals, £42 14s. 5d.; transfer fees, £44 15s.; dividends on securities, £15 2s. 8d.	2,200	14	1
Net amount of expenditure carried to balance-sheet	£352,752	9	1
Balance	9,833	10	11
	£362,586	0	0

Dr. BALANCE-SHEET, JUNE 30, 1892.

	£	s.	d.
Capital account, receipts as per statement	362,586	0	0
Sundry tradesmen and others due on construction of plant, machinery, fuel, stores, etc., to 30th June, 1892	23,398	16	10
Sundry creditors on open accounts	4,544	12	10
	£390,529	9	8

Cr.	£	s.	d.
Capital account, expenditure as per statement	352,752	9	1
Sundry debtors for rent, etc.	834	3	9
Sundry debtors for current supplied	2,052	3	4
General stores on hand	4,332	5	8
Sundry deposits under provisional orders, etc.	7,001	0	9
Expenses of subsequent issues of ordinary capital £2,005 2s. 4d., less premium received on 6,258 shares £1,564 10s.	440	12	4
Cash at bankers	23,116	14	9
	£390,529	9	8

BUSINESS NOTES.

Western and Brazilian Telegraph Company. The receipts for the week ended August 19 were £2,603.

Agent Appointed.—Mr. Leoline A. Edwards, of 19, Laurence Pountney-lane, Cannon-street, E.C., has been appointed sole London agent for T. L. Hemming and Co., Limited, electrical engineers, of Birmingham.

Ludgate-hill.—The most recent addition to their orders for the electric light received by Messrs. Evans, Stewart, Palmer, and Co., is a large installation they have commenced at Nops's Electrotype Agency, 19, Ludgate-hill, E.C.

Electricity Supply Corporation, Limited. This Company has declared an interim dividend for the half-year ended June 30, 1892, at the rate of 5 per cent. per annum on the ordinary share capital of the Company, after payment of all interest on debentures.

City and South London Railway Company.—The receipts for the week ending August 21 were £724, against £728 for the same period of last year, or a decrease of £4. The total receipts for the half-year have been £6,148, against £5,680 for the corresponding period of 1891—an increase of £468.

Newcastle.—Messrs. Ernest Scott and Mountain, Limited, Close Works, Newcastle-on-Tyne, are extremely busy in both their electrical and engineering departments. In the former department they have just secured the contract for the lighting of the Co-operative Wholesale Society's premises in Waterloo-street and Thornton-street, Newcastle-upon-Tyne. This installation is perhaps the largest driven by gas engines in the kingdom, the plant consisting of three 25 n.h.p. nominal gas engines to give 55 effective horse-power each, three "Tyne" compound-wound dynamos to run 600 16-c.p. lamps each, and about 800 16-c.p. lamps fixed throughout the premises. In addition to this the firm have the contract for lighting the Ashington Colliery throughout, and are also lighting Messrs. Chadwick Bros.' mill in Russia. They have more recently secured the contract for an electric pumping plant for the Newton Colliery Company; this plant is to be capable of delivering a maximum of about 200 gallons of water per minute. In the engineering department, they are extremely busy with their specialities in connection with auxiliary machines for warships. They have in the hand for the Admiralty six duplex pumps of the Worthington type, with cylinders 9 by 6 by 9; they have also in hand an order from the India Office for their Admiralty type of pump, and are building a considerable number of this type of pump also for various contractors doing Admiralty work. They are also busily engaged with electric fans, having recently received orders for a considerable number.

PROVISIONAL PATENTS, 1892.

AUGUST 15.

14674. **Improvements in electric telephonic transmitting apparatus.** Alexander Marr, 70, Market-street, Manchester.

14676. **Improvements in commutatorless direct current dynamo-electric machines.** Arthur Cuthbert, Rosebourne, Castle Hill, Maidenhead.

14709. **A method of making and using bionomic baths, to mechanico-chemically and hydro-electrically exalt the health of the people.** James Darsie Morrison, 8, Quality-court, Chancery-lane, London.

14719. **Improvements in and relating to electrical storage batteries.** Thomas Floyd, 11, Furnival-street, Holborn, London.

14720. **Improvements in and relating to electrical storage batteries.** Alfred James Jarman, 11, Furnival-street, Holborn, London.

14738. **Improvements relating to electric arc lamps.** Carl Coerper, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

AUGUST 16.

14769. **Improvements in brushes for dynamos.** William Phillips Thompson, 6, Lord-street, Liverpool. Howard Henry Cherry, Seward Dover Younglove, Louis House, and William Chandler Raymond, United States. (Complete specification.)

14799. **Improved electrical switch.** Arthur Henry Vesey, 70, Chancery-lane, London.

14805. **Improvements in electric arc lamps.** Henry Robert Low, 41, Beaconsfield-road, Twickenham.

14806. **Improvements in motors for alternating currents.** Henry Robert Low, 41, Beaconsfield-road, Twickenham.

14813. **Improvements in electric battery plates.** Edward Preston Usher, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14814. **Improvements in storage batteries.** Edward Preston Usher, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14815. **Improvements in storage batteries.** Edward Preston Usher, 45, Southampton-buildings, Chancery-lane, London. *(Complete specification.)*

14816. **Improvements in electric battery plates.** Edward Preston Usher, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14819. **Improvements in and relating to electric arc lamps.** Hugh Watt, 45, Southampton-buildings, Chancery-lane, London.

14822. **Improvements in incandescent electric lamps.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Eugene McOuat, United States.) (Complete specification.)

AUGUST 17.

14859. **Improvements in telephonic connections.** Harold Lyon Thomson Lyon, 59, Chancery-lane, London.

14886. **Improvements in cut-out switches, and cases for containing and protecting the same.** Augustus Wright, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

AUGUST 18.

14928. **A new or improved non-sparking switch.** Francis Hastings Medhurst, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

14947. **Improvements in the plates or electrodes of electric storage batteries.** Alfred James Jarman, 11, Furnival-street, Holborn, London.

AUGUST 19.

14974. **Improvements in electric measuring instruments.** Walter Thomas Goolden and Sydney Evershed, Woodfield Works, Harrow-road, London.

15002. **Improvements in telephony or means for transmitting telephonic signals through long distances.** Joseph Hines, 6, Lord-street, Liverpool.

AUGUST 20.

15035. **Improvements in automatic switches.** John Hall Rider, Northern Telegraph Works, Halifax.

15038. **Improvements in electrical winding mechanism for clock movements.** Adolph Edward Vidal and Gaston Herview, 9, Warwick-court, Gray's-inn, London.

15057. **Improvements in electric arc lamps.** James Brockie, 28, Southampton-buildings, London.

15059. **Improvements in portable electric incandescent lamps and in battery cells and fittings therefor, also partly applicable to electric batteries generally.** Henry Charles Gover, 28, Southampton-buildings, Chancery-lane, London.

15060. **Improvements in electrical cut-outs for high-tension currents.** Charles Edmund Webber and George Hinde Nisbett, 70, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1891.

5014. **Electric lamps.** Swan. (Fourth edition.)

5329. **Electric safety lamps.** Bristol. (Second edition.)

7278. **Electric switches.** Percival.

12703. **Electric switchboards.** Hawkins and Newton.

12934. **Electrical parcel exchange system.** Bennett.

13125. **Carbon holders and screens for electric welding.** Howard.

13280. **Electrical conduits.** Munro.

14134. **Thermodynamic machines.** Watkinson.

15377. **Electric globe gallery, etc.** Whitehead.

16800. **Electrical fittings.** Snell and Woodhouse and Rawson United, Limited.

17227. **Electric cables.** Howell.

17324. **Electric lighting.** G. J. and G. J. T. J. Parfitt.

18083. **Electrical bells, etc.** Harness.

1892.

12057. **Printing telegraphs.** Lanville.

12191. **Electric railways.** Mills. (Johnson.)

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	[illegible]
Pref.	—	2¼
India Rubber, Gutta Percha & Telegraph Co.	10	20½
House-to-House	5	3¾
Metropolitan Electric Supply	—	7
London Electric Supply	5	4
Swan United	3¼	3½
St. James'	—	8
National Telephone	5	4¾
Electric Construction	10	[illegible]
Westminster Electric	—	6
Liverpool Electric Supply	10	4
	3	3¼

NOTES.

Taunton.—The extension of the underground mains has been commenced.

W. H. Preece.—Our contemporary, the *Machinery Market*, contains a portrait and biographical sketch of W. H. Preece, F.R.S.

Eastbourne.—In Eastbourne, in spite of the electric light, the gas company's business compels them to spend £10,000 for extensions.

Glasgow.—The æsthetic population of Glasgow are exercising their minds about the possible disfigurement of Kelvinside by a central station.

Electric Launch Company.—The Thames Electric Launch Company has been taken over by Mr. Andrew Pears. Mr. Sargeant remains manager.

Bradford.—Electrical communication is now used for fire alarm work. The necessary apparatus has been installed by Mr. O. Firth, electrical engineer, of Bradford.

Derby.—Tenders for electrical plant for Derby will be required soon. Messrs. Bramwell and Harris are the engineers, and tenders for the buildings are already invited.

Kingswood.—Complaints of the power of the incandescent lamps at Kingswood have elicited a reply from the company that they are intending to put in fresh lamps.

Budapest.—The Municipal Authorities of Pest have signed a contract with the local gas company for the general introduction of the electric light for the illumination of the public streets.

Taunton.—The crusade against the electric light is still continued, but it is clear from whence it arises. Mr. J. Standfast, writing to a local paper, says "the gas company having proved too strong for them."

Calcutta and Madras Telegraph.—The length of the new wire which the Telegraph Department is about to erect between Calcutta and Madras, through Manmad and Nagpore, is stated to be 19,000 miles.

Genoa.—We learn that a favourable report has been received by the Superior Court of Genoa from the State Railway Commission to grant the concession for an electric tramway on the Sprague system, to be opened by the 31st of December next.

Conservative Club.—The Conservative club in St. James's-street, which is being redecorated, is to be wired for some 400 electric lights, under the superintendence of Mr. A. A. C. Swinton as consulting engineer. Tenders for the work have already been obtained.

Brain's Conduit System.—On Tuesday last an experimental line on this system was inspected at the works of the Telegraph Manufacturing Company, at Helsby. Our description of this system must remain over for another issue, when we hope to illustrate its peculiarities.

Electrolysis.—According to the *Journal* of the Electrical Society, M. A. Chassy proposes to substitute the following for the law as enunciated by Faraday, Becquerel, and Wiedemann: "When any substance whatever is electrolysed there is always liberated an equivalent of hydrogen, or the corresponding quantity of the electro-positive radicle.

Railway Carriage Lighting.—The new Royal saloon carriage for use on the Belgian railway has been fitted by the State railway engineer very completely with electric light. Julien accumulators are used, giving light for 10 hours. The recharging is effected at either of the stations which have electric plant. This carriage is the first to be lighted electrically in Belgium.

Colon.—We understand that the lighting of the town of Colon (in Cuba) has been given to M. J. Vallice, of Matanzas. The installation will be on the three-wire system, the mains being of naked wire carried overhead. It will comprise 1,200 incandescent lamps of 16 c.p., and 20 arc lamps lighted by two Desrozier's machines, and is to be carried out next November.

Electric Bath.—A new idea is described as a bath of electric light, the head being placed in a chamber full of incandescent lamps. The effect is said to be salutary and pleasant. The men in a testing-room get plenty of this kind of bath. Still, a company might earn sixpences for electric baths as well as for letting in the public to see the machinery, which itself might more often be done.

Telford Medals.—The Council of the Institution of Civil Engineers have awarded a Telford medal and a Telford premium to Alexander Pelham Trotter, B.A., A.M.I.C.E., for his paper on "The Distribution and Measurement of Illumination"; a Telford premium to Charles Preller Shiebner, Ph.D., A.M.I.C.E., for his paper on "The Florence and Fiesole Electric Railway"; a Miller prize to Charles Henry Wordingham, A.K.C., Stud.I.C.E., for his paper on "Meters for Recording the Consumption of Electrical Energy."

Marseilles.—An electric tramway has recently been established at Marseilles to serve the outskirts of the town in the direction of the Aix route. The line commences at the Cannebiere, ascends the Rue d'Aix, which has a gradient of 6 to 7 per cent., and proceeds as far as Saint Louis. Here is situated the terminus of the *octroi* depôt, and various important refineries and blast furnaces. The total length of the tramway, which consists of a double line nearly the whole of the distance traversed, is three and three quarter miles.

Dundee.—The Finance Committee of the Dundee Gas Commissioners have fixed the price of the electric light which is being introduced into the city at 5d. per unit, being 1d. less than is authorised by the Electric Lighting Order, and 1d. less than the price charged at first elsewhere. It was stated that the Secretary for Scotland had approved of the proposed borrowing for electric lighting purposes, the sinking fund being fixed to extend over 60 years. It is expected the works will be completed and the light supplied by November.

Alternating Current Motor.—Mr. Shippey brought in for our inspection this week one of the new alternating current motors which he is putting on the market, under the name of the "Pioneer." It it a small and neat motor, with two-pole single magnet wound with one coil. The peculiarity is in the armature, which is double wound with heavy and thin wires. It has a commutator like an ordinary motor and is self-starting. The one we were shown was fitted to a ventilating fan, and the motor, which is about ½ h.p., should prove very useful for this purpose.

Communication with Lighthouses.—The Royal Commission appointed to enquire into the subject of electrical coast communication arrived at Plymouth in the "Enchantress" from the Scilly Isles, and, after taking the evidence of local witnesses, left for the Start, Portland, and Portsmouth. In their present course they have inspected most of the lighthouses and lightships between Liverpool and Plymouth, and along the east coast of Ireland. Next week they proceed to the Goodwins, and after visiting also the Thames group of lights, will voyage north to Edinburgh.

City Transformer Sub-Stations.—The Consistory Court of London was applied to on Monday to grant a

faculty to authorise the construction by the City of London Electric Lighting Company of a transforming chamber in the churchyard of St. Nicholas Cole Abbey. The Chancellor of London reserved judgment. A similar course was taken in the case of the application that was made for a faculty to authorise the construction of a transforming chamber in the churchyard of St. Benet Finck, Royal Exchange-avenue. It is expected, however, that no difficulty will be raised.

Derry.—On Tuesday night some thousands of the citizens of Derry assembled in the Diamond and adjoining thoroughfares to witness a trial of the electric light, for the purpose of street lighting, under the auspices of the Corporation. The trial was a great success, and there has rarely been a better and steadier display. Mr. Blake is the acting electrical engineer. It is well known that many places in Ireland are looking forward to having the electric light, and at the forthcoming meeting of municipal engineers to be held in Belfast no doubt opportunity will be taken to examine into the question.

Italian Government Decree.—A decree upon the distribution of electrical energy has just been issued by the Italian Minister of Posts and Telegraphs. All instructions upon the insulation of wires, transformers, fittings, and so on are set forth. No high tension wires are allowed overhead in towns. All continuous currents above 300 volts, and alternating currents above 150 volts, are considered "high tension!" The decree seems to be a kind of Italian Board of Trade act. We hope it will not tend to discourage the extension of electrical enterprise in Italy, where up to the present great progress has been made in the electrical industry.

A Timely Reminder.—Those in charge of the machinery at central stations should remember that it is friction and not work that wears out a machine. It is, therefore, the object of every good mechanic to lessen the friction of every bearing surface, either by strict attention to the character of the bearing surfaces themselves, or by the application of carefully selected lubricators. Lubricators are used freely, too freely sometimes, on almost all machinery, but it is not always that the operators understand the nature of the lubricant that they employ, and consequently it often happens that they make anything but a wise selection.

Trafalgar-square Theatre.—This new theatre, which has been leased by Mr. Levenston, was thrown open on Wednesday night to the inspection of a large number of invited guests. It is situated in St. Martin's-lane, and may be described as of medium size, approximately to the Prince of Wales's. Mr. Emden, from whose designs it has been built, has provided for some 1,200 spectators. In the matter of upholstery an innovation has been successfully attempted. The prevailing hue of the interior is amber, which has a beautifully soft and delicate effect. The theatre is lighted by electricity, and the drop curtain represents a view of the Thames Embankment.

Croydon.—The chairman of the Croydon Gas Company when questioned at the half yearly meeting on the prospects of competition by electricity, expressed the opinion that there were very few shareholders in gas companies who would venture to speculate in electric lighting shares in Croydon for a few years to come, at any rate. He ventured to think that so long as they could sell gas at 2s. 10d. a thousand, the use of the electric light would be very limited in Croydon. As soon as they felt they could do so with confidence, the directors would lower the price of gas still more, and be able to cope with electricity in Croydon even better than at present.

Reading.—The Reading Gas Company, confronted by the electric light, as promoted both by a company and the Corporation, has decided on a Fabian policy. "Your directors," said the half-yearly report, "have observed that a company called the 'Reading Electric Supply Company, Limited,' and the Corporation of Reading have each taken preliminary steps for obtaining power by means of a provisional order of the Board of Trade for the purpose of supplying electricity for both public and private lighting. When the plans of the above two bodies are more matured, your directors will be prepared to take such steps as they may deem necessary for protecting the interests of the shareholders of the company."

Mill Lighting in India.—The *Indian Engineer* states that Messrs. N. N. Wadia and Sons, engineers, have fitted up at the Sir Dinshaw Petit Mill, at Tardeo, an installation of electric light, and nearly completed the plant for the transmission of power by electric means. This innovation is also put up by the City of Bombay Mills, at Chinchpoogly. It is the intention of the agents of both mills to work from seven o'clock in the evening to three or four the next morning by a second relay of hands. The present spurt given to the twist market is due to a large demand from China, which has sprung up quite unexpectedly. Almost all the mills have sold their production in advance up to the end of the year, and it is probably to meet such extra demand that electric lights are to be fitted up in the mills to work them at night.

Rotherham. — A correspondent of the Rotherham paper strenuously objects to the extension of the gas works, as the nuisance from them is already almost unbearable. He wants to know why electricity cannot be introduced, not only for lighting, but to supply electricity to give motive power for many small manufactures, such as stocking weaving, printing, driving sewing and sausage machines, and many others. For lighting purposes in the day time, only half-price, or threepence per unit might be charged, as at St. Pancras. He adds: "If our Corporation do not introduce the electric light, it is almost certain that in a year or two some other company will obtain powers to do so." He wishes they would, for "the advantage to the public health over our present barbarous system of burning gas in confined rooms will be incalculable."

Boiler Economy.—As is well known amongst engineers, the boiler is the least satisfactory part of a steam plant. Engines and dynamos can be made to give a combined efficiency of 85 or more per cent. from ingoing steam to outgoing watts. The boiler is the point where the greatest loss of coal energy takes place (after the always present loss of heat in actual steam conversion, of course), and the attention of engineers has been directed to this question with a view of preventing some of these added losses. Amongst these attempts at progress we see some have been directed to the prevention of corrosion and incrustation by the direct means of enamelling the whole interior of the boiler. It is stated that firms in Glasgow have found this process extremely successful, and that further tests will be made and the results published.

Bath.—The first of the fortnightly reports from Mr Gatehouse to the Bath Surveying Committee, as to the electric light, was submitted at the last meeting. It stated that there were 84 lamps burning $7\frac{1}{2}$ hours a day. Eight had been out for periods varying from 20 minutes to three hours. Six of these were out on the same night, and the regulation and cleaning of the lamps had been badly done in each case. Other particulars as to pressure, current, average energy, resistance, etc., were given, and Mr. Sturges said it was not necessary to report this. It would not be understood. The Chairman: Hebrew! Mr Ricketts

thought the inspector should give all the information. Mr. Morris also thought the entries should be retained, but it was of no great service to read them. The committee took this view of the subject. The report was passed.

Water Power and Electricity.—Arrangements have just been completed for lighting Overtown, the baronial residence of Mr. J. Campbell White, amidst the hills overlooking the Clyde, by electricity generated by the water power which is so abundant in this part. The installation, according to the technical description in *Engineering*, is for 300 lights of 16 c.p. It is computed that the system, as compared with the gas, which it supersedes, will in three or four years have paid for itself. The waters from the neighbouring hills are gathered into a reservoir of 700,000 gallons capacity, and into it there is said to be a continuous supply. From this point a 12in. cast-iron pipe is laid a distance of 640 yards to a turbine and dynamo house at the foot of a glen, the fall being 170ft. There are two turbines, each driving a separate dynamo, so that the plant is in duplicate, and thus there is little likelihood of the current falling at any time.

Ship Lighting.—A new steamboat, the "Grange," built by Messrs. Wigham, Richardson, and Co., of Newcastle-on-Tyne, for the Carron Company's service between London and Grangemouth, in the Edinburgh and Glasgow trade, made her official voyage on Tuesday from Tilbury out to sea and back to the company's wharf near the Tower. The party on board included Mr. McLaren, director, acting for Sir John Brodie, chairman of the company; Sir E. J. Reed, M.P.; Mr. Tweedy, representing the constructors of the ship; Mr. Cowan, Mr. Jardine, Mr. Robertson, a number of guests, several of the older officers of the company, acting in other days, and Captain Francis Carne, one of the new school at the head of passenger steamers. The vessel is splendidly engined, is furnished throughout in modern style, and electrically lighted. The "Grange" is 280ft. in length, 36ft. breadth, 17ft. depth, of 1,517 gross tonnage, and of 4,000 h.p.

Great Northern and City Railway.—On June 28th last the Royal Assent was given to a Bill for the construction of a new underground electric railway between Moorgate-street and Finsbury Park. The necessary preliminary details have now been worked out by the engineers, Sir Douglas Fox, Mr. Francis Fox, and Mr. J. H. Greathead, and the construction of the line will very shortly be commenced. A land valuation has been made by Messrs. Vigers and Co., and they estimate the cost at some £400,000. The whole cost of construction will exceed £1,200,000; this sum, however, includes everything with the exception of plant. The first directors of the company, which is to be called the Great Northern and City Railway, will be Lords Camoys and Lauderdale, Messrs. Roger Richards, Daniel Bayley, and John Hamlyn Boner, and the required and authorised capital is £1,500,000. The terminus will be at Moorgate-street, and stations will be built at Essex-road, Drayton-park, and the rail junction with the Great Northern Railway at Finsbury Park.

Dublin.—The correspondent of an Irish newspaper says, with reference to the Dublin lighting: so far the electric light in Dublin is a decided success. Every person you meet is for it. All the leading streets are lit with it. During the week thousands of people admired it, especially in O'Connell-street, where the lamps are placed at each side of the street, and so brilliant is the light that you could pick up a pin off the flags on either side. The gas-lights are still there, but they look only as yellow specks beneath the great white electric lamps, which are on metal posts not quarter as high as the wooden poles which support the electric lights in your city. It is now introduced into several hotels, and other places of public resort in Dublin. The corporation intend to light not only the large streets with this light, which is their own, but every one of the small streets as well with smaller lamps. It is said that the shopkeepers and merchants will also take it in as soon as the corporation are prepared to give it to them—so that in course of time it is believed it will prove a large source of revenue to the municipal body.

Electric Launches.—The following details are given of an electric launch known as the "Electra," built by the Electric Launch and Navigation Company of New York, for passenger service on the enclosed waters of the World's Columbian Exposition. She was built at Bay Bridge, and is 34ft. long over all, with a load water-line of 31ft. 6in., beam 6ft., and draught 26in. The storage batteries of the "Electra" are arranged along the hull the whole length of the craft, with seats on the top of them. The batteries are connected in parallel, but can, by means of a switch, be connected in series, and will, when so connected, give a maximum speed of 12 miles an hour; the normal speed, however, is 7 miles per hour, the company stating that they have found that the mileage by a single charge varies inversely as the square of the speed. The motor of the "Electra" is 4 h.p., but is capable of developing 12 h.p. Its normal speed is 600 revolutions, and its armature is coupled direct to the propeller shaft, which is constructed of Tobin bronze. The boat is fitted with electric lights and various electrical attachments, including a signalling trumpet.

Electric Lighting Plants.—A very neat guide to private house lighting has been issued by Messrs. Drake and Gorham, who have an acknowledged position in this class of work. Their book "Electric Lighting Plant and Accessories" contains some neat sketches of a small steam plant suitable for private house lighting. A semi-portable engine is shown driving a dynamo by belting in a neatly arranged engine-room, with tiled floor and electrically lighted, of course, with regulating switch at one end. Alongside, but partitioned off, is the coal bunker and an accumulator room, making a compact installation. A plan of this engine-house is also shown, so that a householder sees exactly what he is going to get. Another view shows a gas or petroleum engine plant in the same way. The pamphlet contains full particulars of wires, fittings, switches, and so forth required, and a number of well-cut blocks show the different switches and switchboards that can be used. There are prices of all these things, as well as instruments, and sample estimates for 50 and 100 light plants make a complete store of information for intending purchasers of installations.

Peckforton Castle.—An important electric light installation is being carried out at Peckforton Castle, Cheshire, the seat of Lord Tollemache, by Messrs. Barclay and Son, electrical engineers, of Regent-street, under the superintendence of their engineer, Mr. Ardebut. An engine-house has been built near the entrance to the grounds, which contains a 40 h.p. Robey engine, of the locomotive type, which serves the double purpose of working a sawmill and the dynamo. The latter is one of the new type of dynamos on the Scott-Sisling patent. It charges 56 E.P.S. accumulators. The whole arrangement is on the same plan as the "model country house installation" exhibited by the firm at the Crystal Palace, for which they obtained a silver medal. From the engine-house a cable, 900 yards in length, conveys the current to the castle. The wiring is being carried out on the concentric system, which requires no casing, takes up a very small

space, is very neat in appearance, and somewhat cheaper than the usual method. We fancy it is the first instance of a large private installation of this kind which has been fitted throughout on the concentric system.

Bradford.—The Gas and Electricity Supply Committee of the Bradford Corporation are making arrangements for the extension of the electricity works. The enlargement consists principally of the erection of two sheds on ground already enclosed, and of the laying down of a steel Lancashire boiler. These arrangements are being made in view of the increase in consumption that naturally takes place on the approach of winter. Last winter there were only three boilers at work, and the resources of the department were severely taxed. About midsummer a fourth boiler was laid down, but it was felt that a fifth was needed before the works could be fairly said to be ready for an emergency. How long this particular addition can be considered as spare plant it is hard to foretell. The demand for electric light is steadily growing, and very shortly the department will have to supply 700 lights for the Victoria Hotel, which is now been renovated. About 17 miles length of cable has now been laid down in the Bradford streets. This, however, only represents an actual distance covered of about four miles, though the busiest part of Bradford is now well supplied.

Maidstone.—At the last meeting of the Maidstone Local Board of Health, the following report was presented on the lighting question: "Your committee have had under consideration the question of preparing estimates and a scheme for the electric lighting of the borough, and the engagement of an efficient electrical engineer for that purpose. Two engineers have attended before and been interviewed at length by your committee. Your committee now recommend that Mr. W. C. Hawtayne be engaged by your authority to prepare the necessary plans, estimates, and specifications, and carry out the entire scheme. That Mr. Hawtayne be required to reside in Maidstone during his engagement. That he be permanently engaged to manage and start the lighting, and be required to act as residential engineer in charge of the works for a period of at least 12 months after completion. That during his engagement Mr. Hawtayne be paid a salary of £300 per annum." The adoption of the report was proposed by Mr. Barker and seconded by Mr. Cox, but in the course of the discussion which followed, the majority of the members were of opinion that the matter should be more fully discussed. A special meeting of the whole Board has been called.

Charging Accumulators by Alternate Currents. We mentioned some few weeks ago the news which until then had been unknown to English engineers, that the method had been found for charging secondary batteries by alternating currents. This statement was received with a good deal of incredulity, as was only natural, and yet at the same time so much has been done with alternating currents that the feeling was present, why not this any less than the other discoveries? We have recently had this news confirmed by one of our correspondents from Paris, who is in close communication with MM. Hutin and Leblanc, who are the experimenters in question, and we are assured that the method is certainly a practical success, at any rate on the scale on which it has been adopted in their works. The rectification of the current is carried out by special apparatus of the nature of condensers, which we hope to be able to publish before very long. It is too early, of course, to be led to believe that new central stations will be operated on this principle for some time, but if the practical difficulties are overcome, there is every reason to suppose that this method of storing the energy of the alternating current will prove as useful to engineers as the storage of the direct current.

Waterford.—On Thursday last week a special meeting of the Waterford Town Council, convened by the Mayor on the requisition of some members, was held to re-consider the question of the public lighting of the city; to rescind the resolution passed on the 11th inst. accepting the gas company's tender; to rescind a previous resolution deciding to light the city by oil; to accept the offer of the electric light company to light the city for six months; and to take competent advice on electric lighting generally. The Mayor presided. Alderman Toole proposed the resolution, and went into figures to prove that electric light was cheaper than gas. The Corporation of Dublin had a splendid installation for £20,000. Mr. Smith interrupted here, and said the estimate for the lighting of Dublin by electricity was £38,000. Alderman Toole stuck to his assertion that only £20,000 was expended in establishing the installation in Dublin. He mentioned that by sticking to their agreement with the gas company the Corporation would be sacrificing their provisional order, which cost them £500. Were they, in face of all he had pointed out—in face of the progressive tendency of the age—going back to the same condition of things that existed in the city 40 years ago? Alderman Redmond seconded the motion. The meeting was interrupted with many personalities, and the motion was defeated by 19 votes to seven.

An Electro-Photographic Thief Detector.—For some time past Mr. Triquet, a cigar merchant, of Toledo, Ohio, has missed cigars from the showcase in his office, and although the premises were watched by detectives for several days nothing unusual was observed. As a last resort he applied to an inventor of a flash light photographic apparatus worked by electricity. The apparatus was placed in the office and left to itself. A few days later it was found to contain a flash photograph showing two boys opening the glass case. The picture led to their apprehension by the police and subsequent committal to prison. The apparatus consists of a camera placed in a box which is closed by a shutter operated by a spring and escapement released by an electromagnet. The necessary flash light is got by means of a match, which presses against a rough disc. An electromagnet on the top of the camera box when excited by a current releases a detent, and allows the rough disc to strike a light with the match and ignite the flashing powder. All this occurs in a fraction of a second, and the shutter closes on the camera, retaining the photograph. The current is supplied by a battery, and is started in the circuit by an arrangement of contacts which are unconsciously closed by the thief. Thus the boys in opening the glass case unawares completed the electric circuit, which immediately exposed the camera, and kindled the flash light, much to their amazement. The apparatus is illustrated in the *Scientific American* for August 13, where a reproduction of the two startled boys is also given.

Cholera.—The world has been startled during the last week by the daily reports upon the outbreak and spread on the Continent, and a good many persons have had their holidays spoilt—not to speak of the horrors of plague and death in the affected parts. After Russia, Hamburg commenced the round, Bremen and Rotterdam have been seized, and Havre suffers a daily death-roll. We are tempted to ask whether electricity has no part to play in the fight with the deadly plague. It is possible to conceive it has. In Havre, for instance, the sewage is poured into the harbour and the surroundings are vitiated month after month, till the tropical warmth of the autumn germinates the seeds of disease. Means should be taken to neutralise this plague bed in the towns. We happen to know that

the authorities in Havre have already considered the application of electrical purification of their sewage. Plans were drawn out and the contract almost arranged with an influential English firm for a practical working of this method of disinfecting. Unfortunately, political elections intervened, and the scheme fell through. Possibly the execution of the project might have prevented the scores of deaths at this town. It may be worth while to press this aspect of the case forward, for every means possible should be carried out to prevent the outbreak of plagues, and cleanliness of water and air are the greatest factors in this connection. Fresh living air itself is a great aid in overcoming disease, and our use of high-tension electricity in purifying the air of fever wards is not yet sufficiently tested and adopted, and the usefulness of electrical action in stopping the spread of germ generation has been long acknowledged in the science of fermentation. If electricity could only come to the aid of medical science in these matters, electrical engineering would have done a great work in the sanitation of the world.

Fleet Street by Electric Light.—On Monday night Fleet-street was illuminated for the first time by the electric light. The scene gave many causes for reflection, and the lighting was regarded as a brilliant success. Light indeed are now the labours of those who are busiest from dusk to dawn in purveying the world's news. The scene of Doctor Johnson's lucubrations by midnight oil is now rendered vividly lustrous by the aid of modern science, of which the worthy doctor knew nothing, and it would be not less interesting for him to learn—if he could be interested in such matters now—that the scene of his labours was enlightened under the superintendence of one of his ancient enemies, a Scotchman, for the manager of the City lighting, as most of our readers know, came from the land o' cakes. Goldsmith, too, might have given us his opinion on the influence of advancing science on the decay of man; and Lamb—the genial Lamb—he who said he could weep with joy to see the fulness of life in Fleet-street—would have additional reasons for wandering at night, when the street is still crowded though other streets are forsaken, in the ghostly radiance of the electric light. Truly, if any place should be illuminated with the latest and best light, it is here. The most crowded piece of ground, probably, in all the earth, and crowded, too, with men of quick intelligence, leaders of thought in literature and politics, Fleet-street is gradually emerging from the squalor in which too many of the renowned London streets still exist. Noble buildings are rising, the air is clearer and purer, the streets are cleaner by far than in the olden time; and if only electricity can come to show up the dark and dirty courts, and can eventually feed our fires and rescue us from the fog fiend, we shall find Fleet-street one of the handsomest, as it certainly is now one of the most interesting, streets in London.

Electrical Engineering in Japan.—A large and important Government engineering enterprise was recently completed in Japan. Lake Biwa, having an area of 500 square miles, is situated about seven miles from the city of Tokio, and at an elevation of about 140ft. A navigable canal has been cut from this lake to Tokio, involving two miles of tunnelling and an aqueduct of considerable length. At the eastern extremity of the city, to which point the canal has been brought, there is a sharp decline of 118ft., from the base of which the canal is continued to the sea. This difference of level is overcome by inclined plane ways, 2,100ft. in length, on which boats are raised or lowered from one canal to the other. These ways are worked by electric power furnished from a Pelton waterwheel connected with a Sprague motor. The waterfall affords also a very valuable water power, a part of which has already been utilised for various mechanical purposes by means of electric transmission. The power station is established at the foot of the incline, and consists of three 8ft. and two 6ft. Pelton wheels, giving a total of about 600 h.p., supplied with water from the high-level canal by three lines of 36in. pipe, 1,300ft. in length, delivering water to the wheels under a head of about 100ft. These wheels are at present supplying power for three Edison dynamos of 80 kilowatts each, the current from which is distributed about the city within a radius of two miles, running rice-mills, spinning-mills, a watch factory, and various other machinery. One Thomson-Houston alternating-current dynamo of 2,000 volts supplies the city with 1,300 incandescent lights, as well as many arc lights. The above works, involving an expenditure of about £250,000, were planned by and executed under the direct supervision of Mr. S. Tanabe, an eminent Japanese engineer. They are said to be entirely successful, both from a scientific and commercial standpoint, and evidently will be the forerunners of many additional power transmission plants in Japan.

Incandescent Lamps and Current.—It was long thought, says *L'Industrie Electrique*, that incandescent lamps taking few watts were economical, but some experiments of MM. Siemens and Halske seem to point to the contrary. They may be economical for the moment, but after, no. The experiments were with lamps to take normally 1·5, 2, and 2·5 watts per normal candle. The actual watts per candle were determined after a given number of hours of burning, with results given in the following table:

Duration of lighting in hours.	Lamps taking normally 1·5 watts per candle.	2 watts per candle.	2·5 watts per candle.
0	1·52	2·01	2·51
5	1·91	2·03	—
10	2·43	2·21	2·52
15	2·81	2·38	—
20	3·19	2·48	2·52
25	3·40	2·57	—
30	3·77	2·71	2·52
35	4·07	2·91	—
40	4·15	2·98	2·55
45	4·25	3·03	—
50	4·45	3·06	2·69
55	4·46	3·25	—
60	—	3·46	2·71
65	—	3·51	—
70	—	3·63	2·79
75	—	3·67	—
80	—	3·83	2·89
85	—	3·93	—
90	—	3·99	3·01
100	—	—	3·09
110	—	—	3·22
120	—	—	3·26
130	—	—	3·30
140	—	—	3·53
150	—	—	3·58

The result will perhaps be better seen from the following:

	Type of lamps in watts per candle. 1·5	2	2·5
Length of test in hours	55	90	150
Initial luminosity	16	16	16
Final luminosity	4·5	7	10
Initial watts per candle	1·5	2	2·5
Final watts per candle	4·46	3·99	3·58

Showing that the lamps initially requiring final watts soon deteriorate and consume more, while those starting with the higher consumption continue to consume more constantly. MM. Siemens and Halske advise the use of lamps requiring from 3 to 3·5 watts per candle, never using those below three watts.

DUBLIN CENTRAL STATION.

DESCRIPTION OF THE MACHINERY.

The central electric lighting station which has just been erected for the Dublin Corporation is centrally situated in Fleet-street, at the rear of the old Parliament Houses. It comprises (1) engine house, (2) boiler house, and (3) offices and test and switch rooms.

Engine-house.

This is what may well be termed the most imposing part of the station. Here are erected the three sets of the two kinds of plant—viz.: The Lowrie-Hall high-tension alternating current system for supplying current to consumers' houses, and a continuous current Brush system for lighting the streets by means of arc lamps. For the private lighting there are three pairs of compound horizontal non condensing engines of 280 h.p. each, working at a pressure of 140lb. per square inch on the valve boxes and running at a speed of 85 revolutions per minute. High and low pressure cylinders are fitted to each engine, the admission and exhaust of the steam being regulated by the well known patent Corliss valve system. The fly wheels, weighing nearly 10 tons each, are 14ft. in diameter, and are grooved for 12 cotton ropes running direct to the dynamos. The engines are of Irish make, being specially built by Messrs. Coates and Co., of Belfast. There are two main ranges of steam pipes and one range of exhaust piping, the latter running from the low-pressure cylinders of the engines to the feed-water heaters, which are erected at one end of the boiler-house. The engine foundations are built of concrete and granite block from the depth of 16ft., where the solid rock was reached.

The Dynamos.

Coupled direct by 12 1¼in. cotton ropes to the engines are the patent Lowrie Parker alternating current dynamos, each giving an output of 75 amperes at 2,000 volts; or, in other words, each machine is capable of supplying current to 5,600 lamps of 8 c.p., or feeding on to a circuit wired for about 10,000 lamps. They are magnificent specimens of dynamo machinery construction. Their speed is 350 revolutions per minute. The mean speed at which the armature conductor is passed by the field magnets is about 6,000ft. per minute, and the number of alternations 10,000 or 5,000 complete phases per minute. The E.M.F. is 2,000 volts. All three machines are identical. The armature is stationary, with iron core of large section composed of the very best charcoal iron sheets, arranged longitudinally and in the same plane with the magnetic fields, clamped to the frame of the machine and thoroughly insulated.

An important feature of this dynamo is that the armature conductor coils are formed of narrow copper tape, each wound in a plane upon a piece of insulating material of the same thickness as the width of the tape, and rounded at the ends. The coils are thus of a flat link shape, the edges of the tape windings being exposed upon the flat surfaces of the coils, and therefore well able to resist deflection. These coils are placed close together upon the cylindrical inner surface of the armature ring, so that the axis of each coil is radial to the ring, and are secured to the same by strips of wood, screwed to the cheeks, and extended over the ends of coils, outside the line of travel of the magnets. By this mode of construction the whole of the conductor (except a small portion at the ends of the coils with the line of the field and therefore useless for inductive purposes) is placed in a strong and uniform field of force; each turn of the conductor is under exactly the same inductive influence, and at the same distance from the moving poles, and consequently in the best position for efficiency. Another great advantage is that no special means are required to keep the conductors from sagging, or lifting from their normal position; and, as no wiring or other like means are used for the purpose named, the clearance space between the revolving magnets and the standing conductors is reduced to a minimum. Furthermore, as the armature coils are simply secured to the face of the armature, they are easily removed or replaced as required, and this remark applies likewise to the magnet windings. The armature ring is parted upon the horizontal line, so that the upper half is removable for inspection or repairs. The moving part of the machine consists of a solid soft wrought-iron ring, with polepieces securely attached thereto, and is arranged so that the centrifugal force of the whole of the moving parts is taken by the ring. The base plate is of strong box pattern, and strongly ribbed and under flanged where it bears on the slide rails. The frame for supporting the laminated iron armature core is cast separate and bolted to planed facings. The plummer blocks for the bearings are also cast separate from the base plate, and secured thereto by bolts and lugs, and wrought iron wedge keys.

The bearings are two in number, 20in long. They are in halves, jointed on the horizontal centre and fitted with loose brasses, top and bottom. The brasses are of hard phosphor bronze. The bottom brass is so arranged that it can be removed without lifting the shaft, and yet well secured sideways; each bearing is fitted with two combined syphon and sight-feed lubricators. Each end of the bearing is provided with oil catchers, consisting of a chamber all round the shaft, by which the oil passing from the bearings is caught when thrown from the oil throwers provided on the shaft and conducted by a passage formed in the plummer block under the brass to a waste oil tank or receiver formed in the plummer block or the base plate. The shaft is of best mild steel, 6in. in diameter, the side thrust being taken by collars, forged solid on the shaft at each side of one bearing only; double grooves are cut for throwing the oil into the collectors at each end of the main bearings. Mounted on this shaft is a hub of cast iron, attached to the ring, on which the magnets are mounted in such a manner as to prevent any magnetic short-circuiting. The rings on the shaft for collecting the exciting current are insulated from the shaft and from each other by ebonite washers. The brushes and holders are supported from the base plate, and do not interfere with the bearings or plummer block; each ring is provided with two sets of brushes, each set being ample for collecting the maximum current; contact is kept by adjustable springs, and each brush is separately provided with a safe and easy means of lifting and keeping it away from the ring while the dynamo is in motion. Fixed to the dynamo is a pulley of suitable diameter for driving the exciter, turned with grooves for four ⅞in ropes.

The exciter is a series-wound machine, with drum armature, speed 800 revolutions per minute. The commutator is of ample size and entirely free from sparking, and provided with two sets of brushes and holders, each set of brushes being ample for collecting the maximum current, contact being kept by adjustable springs, and each brush is separately provided with a safe and easy means, when necessary, of lifting and keeping it away from the commutator while the machine is in motion. The lubricating and oil catching arrangements are similar to those of the alternating dynamo. Efficient means for tightening and driving the ropes are provided, consisting of two cast iron rails of heavy section, fitted at one end of each with forcing screws, provided with holding down bolts for the dynamo, the nuts of which are of rectangular form and sliding in grooves formed in the rails. The bolts being applied from above are removable without lifting the dynamo. The two rails are securely tied together with cast-iron distance pieces. Similar arrangements are supplied for the exciter.

The approximate weight of dynamo, rails, and exciter is 12 tons. The foundations of the dynamos below ground are all built of concrete from the depth of 15ft. 6in.

At the opposite end of the room are situated the three sets of arc lighting plant, comprising three vertical compound engines and three continuous-current Brush dynamos. The engines are 60 h.p., and run at a speed of 220 revolutions per minute. There are high and low pressure cylinders, the low-pressure being fitted with automatic relief valves. The flywheels are 8ft. in diameter, and grooved for eight cotton ropes, thus coupling the engines direct with the dynamos. These are of the Brush make, giving an output of 10 amperes at 3,000 volts. The speed of the dynamos is 800 revolutions per minute, and each machine is fitted on sliding rails for tightening the ropes. The armatures are of laminated iron, wound with coils in 12 recesses, the opposite coils being connected in series,

the free ends being brought out through the shaft, which is hollow, to the plates of the commutator.

A large travelling crane capable of lifting 10 tons is erected in the engine-room, and is used for moving and erecting the heavy portions of the machinery.

Boiler-house.

The steam-generating plant is comprised of four of the Babcock and Wilcox type of water-tube boilers, each capable of evaporating 8,500lb. of water per hour at a pressure of 150lb. per square inch. The total heating-surface in each boiler is 51 square feet. They are set in two batteries of two boilers each, each battery being provided with a steam receiver having outlets for the connections to the main ranges of steam pipes. Each boiler is composed of 14 sections or slabs, each section being composed of eight best lap-welded wrought-iron tubes 4in. in diameter and 18ft. long, connected at the ends with continuous staggered headers or "up takes" and "down takes," the tubes being fastened therein by being expanded into tapered holes. The several sections are connected at

Fig. 1.—Dublin Central Station, Fleet-street.

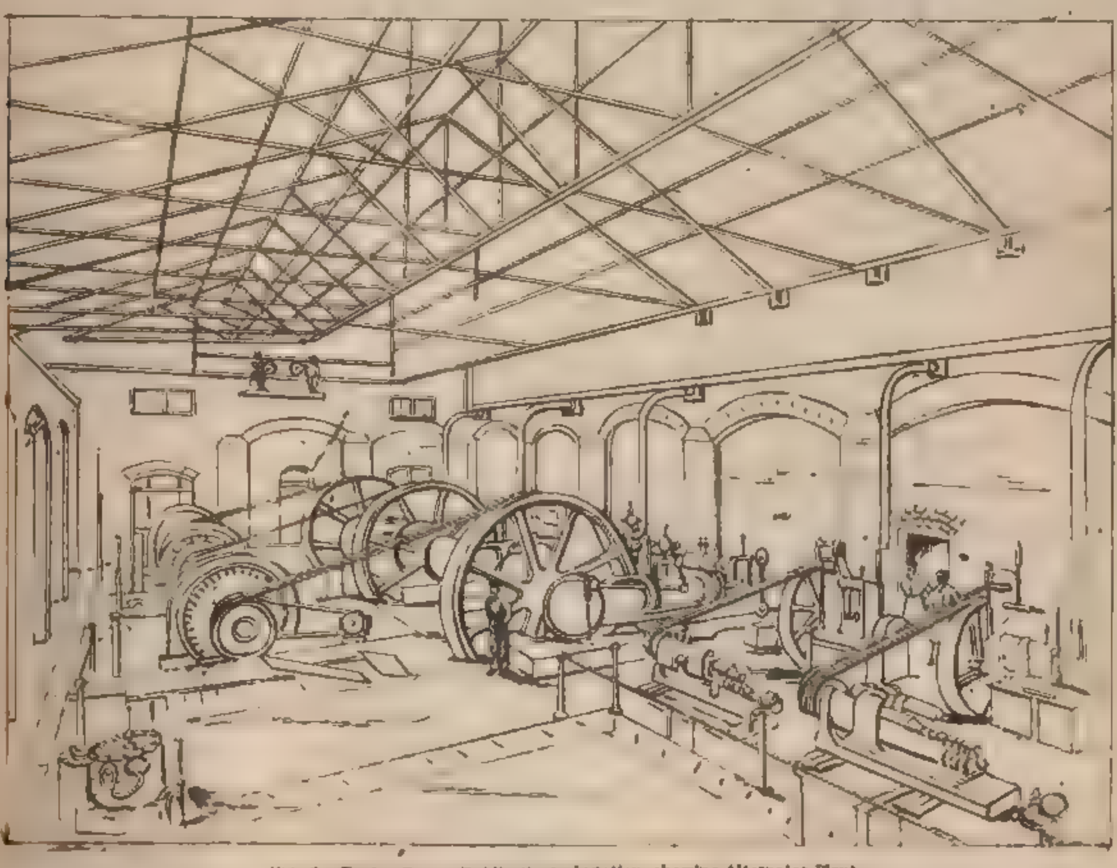


Fig. 2.—Engine Room, Dublin Central Station, showing Alternator Plant.

each end to two steam and water drums, and at one end with a mud drum, by means of lap-welded wrought-iron tubes 4in. in diameter and of suitable length, expanded into cored holes. The steam and water drums are 36in. in

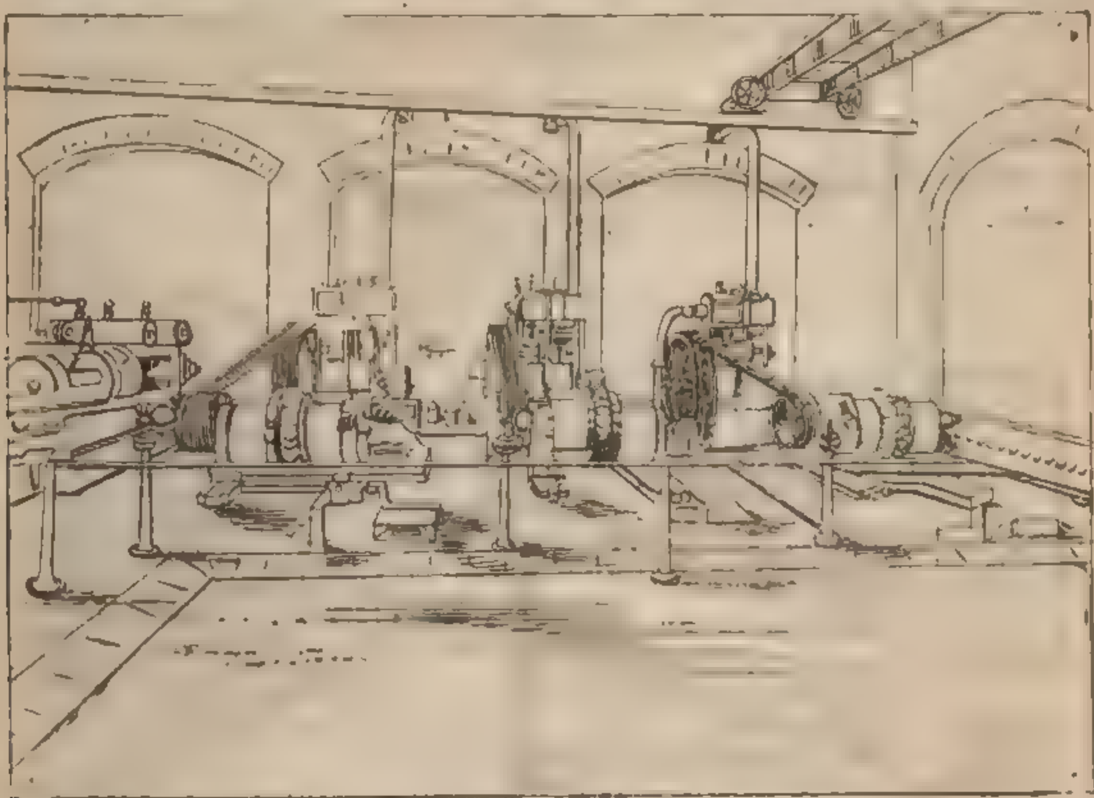


FIG. 3.—Engine Room, Dublin Central Station, showing Arc Plant.

diameter and 23ft 7in. long made of steel ⅜in. thick, and have longitudinal seams double rivetted and provided with a manhole at one end, and two nozzles, one for safety valve and one for taking off steam, 5in. diameter with 11in.

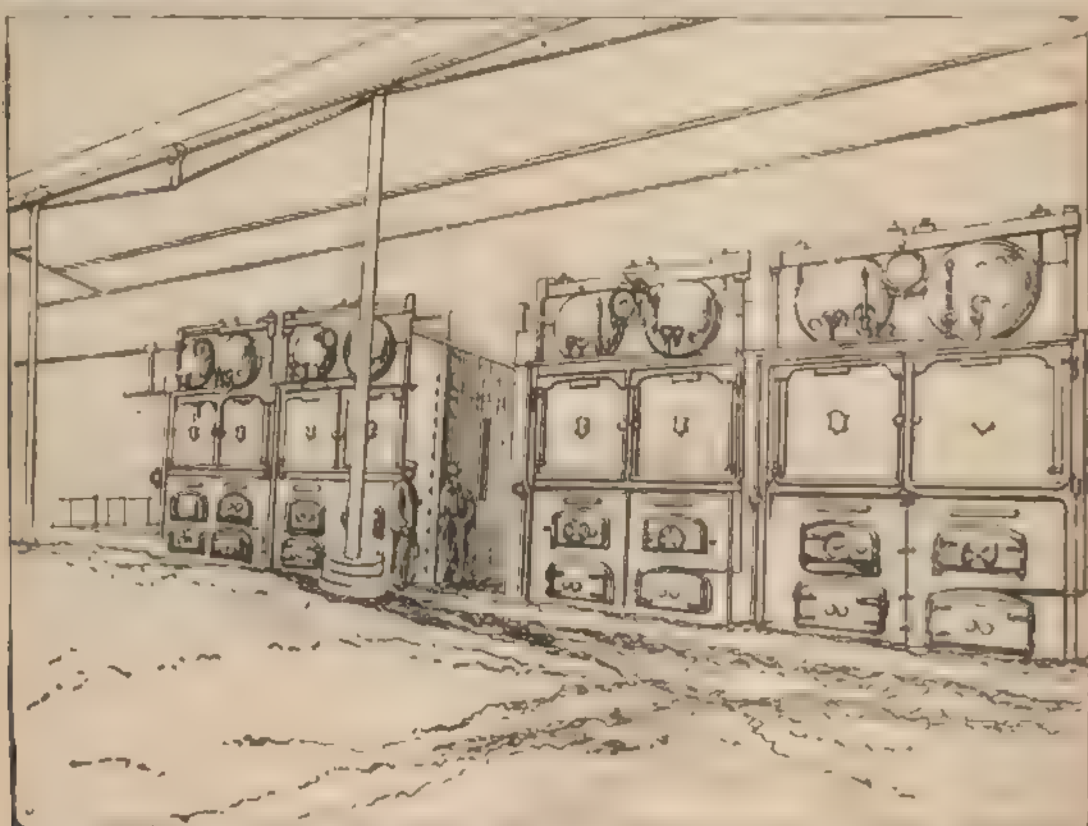


FIG. 4.—Boilers, Dublin Central Station.

flange, faced and drilled. Each boiler is fitted with two safety valves of 5in. diameter, set to blow at 155lb., and there is a steam pressure gauge in front which indicates the amount of pressure of the steam in the boiler.

In close proximity to the boilers are erected three Worthington steam pumps, each capable of supplying water to two of these boilers when fully loaded. There is also all the requisite wrought-iron piping for the connection between the pumps, boilers, and water-tanks, the latter being erected in front of the boilers over the coal bunkers. Close to the large chimney shaft are the three-feed water heaters, each heating a sufficient quantity of water to feed two of the boilers. They are connected with the main exhaust steam pipe, and are fitted with by-passes and a complete arrangement of stop valves to enable the exhaust steam from the engine to be sent through any of the feed water heaters or

past them. The exhaust pipes are carried from the heaters up the chimney to within a few feet of the top.

OFFICES AND TEST ROOMS.

At the east end of the buildings are commodious offices and switch and test rooms. The switchroom, in which all the electrical connections converge, is fitted with a very complete set of instruments for controlling the current and regulating its distribution between the several circuits. The three Lowrie-Parker alternating current dynamos (of 150 units each) are connected by separate leads with the private lighting switchboard, so that any one of them can be run on either of the two mains. The arrangements also permit of the machines being run parallel, and a special synchronising board is provided for this purpose.

It may be interesting to here give a few particulars of this method of running the alternators. The mains from the alternators are first brought to safety fuses in the switchboard, arranged so that a fuse can be instantly replaced without stopping the dynamo, and by a system of four break switches, any dynamo can be put in communication with any circuit or circuits, or the whole of the dynamos be put in parallel circuit. Besides these mains conveying

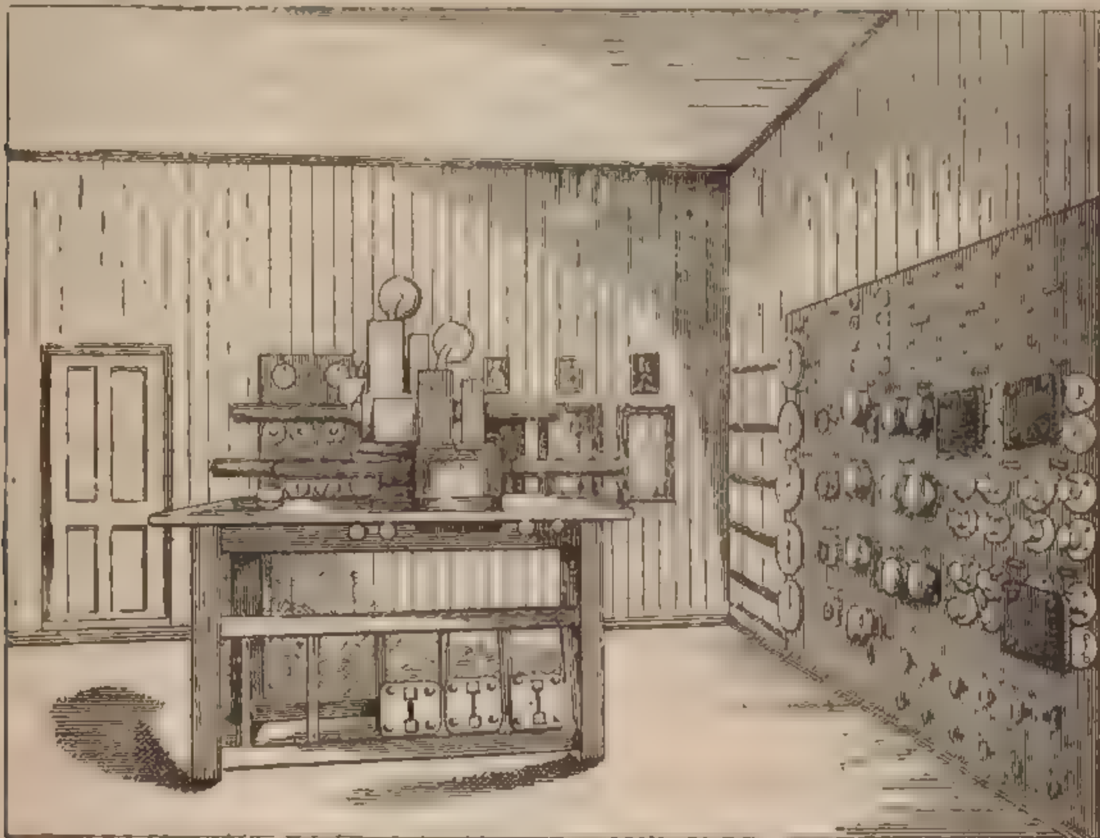


FIG. 5. Switch Room, Dublin Central Station.

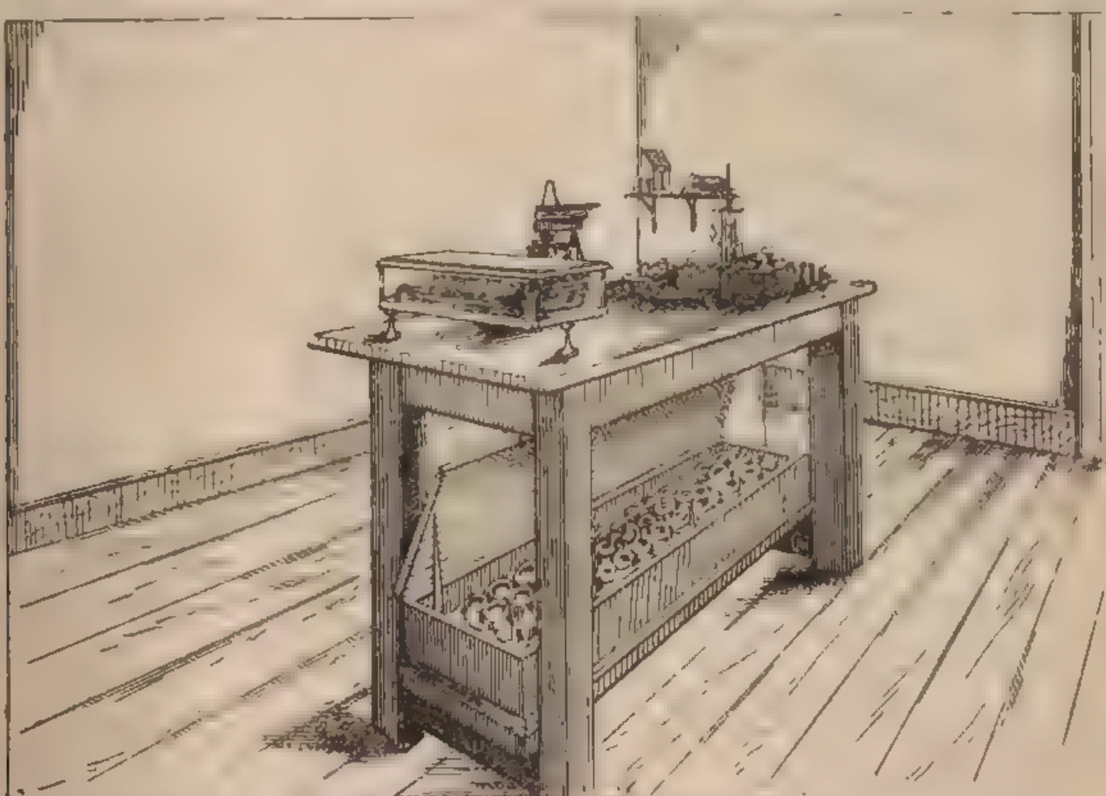


FIG. 6. Test Room, Dublin Central Station.

the entire E.M.F. of the dynamo, a small wire placed across one coil of the armature is also brought to the switchroom; this is for measuring the voltage, synchronising, and for regulating the pressure. Each coil being similar, the measure of one coil is a direct proportion of the whole, and entirely prevents any inaccuracies that would occur in measuring from a transformer. A simple current meter is also included on the switchboard to indicate to the attendant approximately the current given out by each dynamo. When the maximum safe load of any dynamo is reached, the attendant can either put in another machine parallel, or put one of the circuits on some lighter loaded dynamo if working independently. The synchronising is effected through the one-coil circuit; for instance, if one machine shows by the indicator that the load is approaching the normal, and another plant is started, a small switch places the second machine parallel with the first machine, though one lamp only is placed on the synchronising board. When the phases of the two dynamos correspond, the lamp is steady and bright, but not until then. The second machine is then instantly put in parallel with the first by the insertion of one main switch, and at once takes half the load. The slightest inclination of one plant to get out of pulse with the other throws the majority of the work on the faster engine, and reduces its speed, so that one plant entirely controls the other. The regulation is also done from the single coil current, a small converter being interposed between it and the regulator to ensure the attendant from any shocks that might occur from a fault on the circuits or dynamo. It is a very simple, inexpensive piece of machinery, only having to convert a low tension to another about equal.

A complete set of voltmeters and ammeters are provided, the former being of the well known Cardew type. A hand regulator in the form of a variable resistance is placed in the exciter circuits for keeping the voltage constant between the mains. The latter, however, will not as a rule be needed, as three of the Lowrie-Hall patent automatic regulators have been put in connection with the machines. The principle is that of a shunt of varying resistance on the magnets of the exciter. A special feature of the arrangement is found in the main switches. These are made in the shape of four copper plugs attached to a massive block of insulating material with a handle at the back. The plugs fit into porcelain sockets containing brass tubes in connection with the mains, accurately tapered to receive them, and attached to the heavy slate base of the board. A long break is thus made on both poles of the circuit on drawing out the plug handle, and forms a very efficient double-pole switch. The same form of switch is also used in the arc lighting for bringing the dynamos in connection with the three circuits into which the streets are divided. Similar porcelain sockets are also made use of, not only for the switch plugs but also for smaller plugs, to which flexible leads are attached in such a manner that any dynamo can be run on any circuit, or, if it need be, two or three of the circuits can be put in series by simply changing their positions in the sockets.

Automatic regulators of the Brush Geipel type are put in conjunction with each of the arc lighting machines, and serve to maintain a very constant pressure in the mains, and there is thus very little flickering of the lamps. The principle upon which they work is a shunt on the field-magnet circuit of the machines, the excitation of which is modified so as to always maintain the most suitable current in the lamps.

All the instruments for both public and private lighting, with the exception of the automatic regulators, are fixed to the large polished slate bases mentioned above, supported by a strong wooden framework, which forms two sides of the room. Between this framework and the brick wall of the building is a passage of about 3ft. wide, with a trench containing the cables running to the street and dynamos; and from these all the necessary connections to the instruments are made and can always be readily inspected.

THE SYSTEM OF MAINS.

The system of mains for distributing the current in connection with the station is that of the Lowrie-Hall patent. The mains are laid underground, chiefly below the pavements, and consist of lines of cast-iron culverts and boxes, into which the cables are drawn. Various sizes of pipes are used, from 3in. to 6in. in diameter, while the patent Lowrie-Hall surface-boxes are made on the interchangeable system, and are suited to any size pipe, these being placed in the street at a distance of about 70 yards apart. By the aid of these boxes the cables can be easily drawn out and inspected for repairs, if necessary, without any interference to the street from box to box. The pressure on the mains which will convey the electricity to the public street lamps will reach a maximum of 3,000 volts, while the current for lighting up private houses will be transmitted from the dynamo along the cables at the tension of 2,000 volts. Before it enters the houses, however, it is reduced by means of the Lowrie-Hall transformer to a perfectly innocuous current of 100 volts. The wires in the houses will, of course, be highly insulated, but it will be reassuring to nervous persons to know that a contact with a current of this tension, though perhaps it would give a slight shock, is quite harmless and would endanger neither life nor limb.

The transformers used are the Lowrie-Hall patent, and are specially made by the Leeds and London Electrical Engineering Company, Limited, while the meters, which will register the amount of current used by the consumers, are of the Schallenberger type.

At present only the following streets will be lighted by electricity: Grafton street, College-green, Dame-street, Parliament-street, Capel street, Mary street, Henry-street, Sackville street, D'Olier-street, College street, and Westmoreland street. In these streets are erected 78 lampposts, reaching to the height of about 23ft. The lamps themselves are the Brockie Pell patent, recognised for its steadiness and reliability. The light given equals about 2,000 c.p. The testing apparatus consists of a Wheatstone bridge in conjunction with a highly sensitive galvanometer of the Sir William Thomson type, with the usual complement of shunts, a massive reversing, and a large battery of Leclanché cells giving about 115 volts pressure. Most of the instruments in regular use are attached to a table in the test-room of special design with the connections marked upon the top. The galvanometer stands upon a granite column, sunk some 12ft. into the ground to the surface of a hard gravel stratum, the object being to protect the instrument from any vibration which would necessarily interfere with its readings. A complete set of apparatus for re-standardising any of the instruments used in the station is also provided in the shape of a standard current balance, an electrostatic voltmeter, and rheostat resistance, all of the Sir William Thomson pattern. If necessary, the house meters can also be readily tested and recalibrated by means of these instruments. Altogether the testing rooms are fully equipped with the latest patterns of instruments connected with the practice of electric light supply.

The method of testing the insulation of the mains is to take a circuit when the current can be conveniently stopped each day, and then test for insulation with the Thomson deflecting galvanometer and Wheatstone Bridge. This, in a continuous supply, was known to be defective, so a novel and simple instrument has been devised that shows at a glance, and, if necessary, records, any change of insulation in the cables. The instrument used consists of a small box containing a vacuum discharge tube provided with sight-holes. One terminal of the tube is connected to earth, while the other is put to the cable which it is desired to test. If the insulation is good there is a glow in the tube due to the static charge in the conductor, but if there is any defect in the insulation this glow is diminished according to any earth connection which exists. Should any circuit get dangerously low in resistance to earth it is stopped at a convenient time either night or day, and the fault localised and removed in the ordinary manner. By the use of this continuous recorder, a defect can be remedied before it has gone so far as to cause a breakdown, and as all the underground work is very high-class the risk of a defect arising is extremely small.

We have now fully described all the apparatus in use at the central station, and have only to add that it is the universal opinion of the engineers and electricians who have visited the works that it is one of the finest and most complete electric light supply stations in the United Kingdom.

It will be remembered that last year the Dublin Corporation accepted the tender of the Electrical Engineering Company of Ireland to carry out the central station installation. This company had arranged with Messrs. Hammond and Co. for the work of construction, and the latter company has now furnished the installation, a description of which is given above. Mr. E. Manville has acted as consulting engineer to the Corporation, while the immediate supervision of the work has been under Mr. Spencer Harty, the city surveyor, assisted by Mr Ruddle, clerk of the works. Mr. Robert Hammond has personally given a good deal of attention to this work, and was resident in Dublin for a considerable time towards its completion; while Mr. Charles J. Hall and Mr. J. W. Chisholm, of Hammond and Co., have been testing the machinery, and under these gentlemen, the work has progressed in a very satisfactory manner.

ENGINEERS' STORES.

A laundry exhibition is hardly the place where an enquiring mind would expect to find any very novel assortment of stores for engineering shops and central stations. Yet so it is, and at the exhibition now being held at the Central Hall, Holborn, a very creditable show indeed is made by the firm of George Skudder and Co., of 98, Tooley-street. This firm, we find on inquiry, has been established 35 years, and is now in the hands of the two sons of the founder, who actively carry on an extensive trade in asbestos packing of their own manufacture, lubricating oils of their own refining, belts of their own tanning, and stores of various other kinds, produced from their works at Rotherhithe.

A clean and wholesome looking oil, their "B I" lubricating oil, is the principal and most prominent article. This is greatly used for dynamo work at many installations in and around London, amongst others by the famous installations at Messrs. Pears, of "Pears' Soap," and many of the London banks, who nearly all have installations of their own nowadays. This oil is, of course, useful for all kinds of machinery, and the machinery at the exhibition, driven by Hindley's engine, is lubricated therewith.

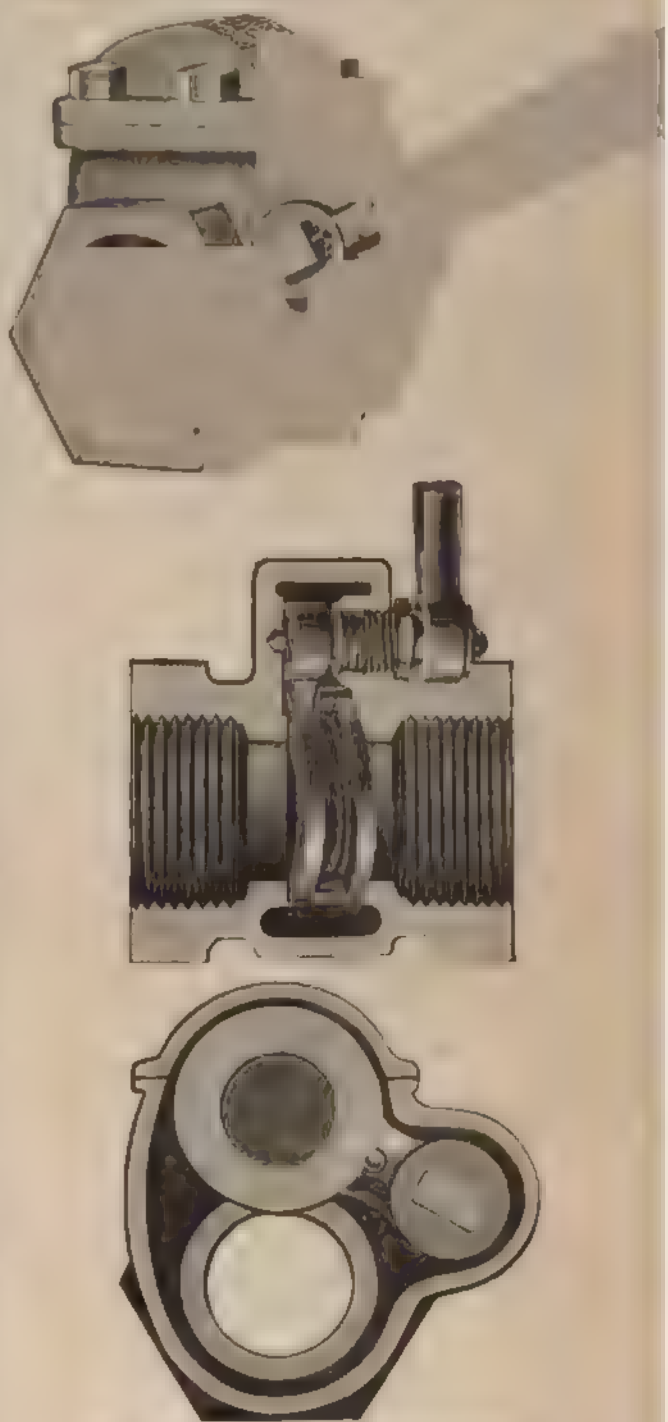
The next article is the "B I" cylinder oil for the cylinders of steam engines—a heavier article; and a third is a special gas engine oil, a fine oil, with a large proportion of lard oil in it, having a high flashing point.

With regard to packing, some interesting samples are made by Messrs. Skudder. They own a half share in a Canadian asbestos mine, and manufacture their packing direct. Rope packing and block packing for pistons, tape for manhole joints, and other sorts and sizes are shown, and asbestos cloth is not forgotten. The ordinary sponge cloths, dear to the heart (and hands) of the dynamo tender and engine man, are here in abundance, white and fluffy, ready to soak up the grease.

An exceedingly useful piece of commodity in engineering works is a removable steam pipe covering produced by Messrs. Skudder and Co. The ordinary steam pipe covering is rather difficult to displace, once it is fixed in position, but by means of making it slightly flexible and in short lengths, and of having a straight joint down one side, attachable by clinching nails, this covering can be removed with the greatest ease whenever repairs or alterations of steam pipes are to be done. This covering is made in different qualities, from the common brown paper up to highly incombustible and non-conducting material for high-pressure pipes. Amongst the other stores on view are to be seen tube and flue brushes, made excellently well with twisted spirals of steel—warranted to last for years of use—and the new patent metallic tubing, here shown applied to a variety of uses, and adjusted to be easily connected together in various lengths.

There is a peculiarly useful thing in steam valves, called the handy valve. Instead of having the ordinary milled wheel for turning by hand, difficult to deal with when, as sometimes happens, the valve is up in the roof, these handy valves have an arm to work the steam passage, and this is moved by a cord or rather a couple of cords, one for turning on and the other off. The action is easy and efficient, the position of the arm showing the extent of the opening, and it makes a very useful variation of steam valve for an engine-room where trouble is desired to be saved, and where the pressures are not over 100lb. to the square inch.

Sight feed lubricators for dynamos are not forgotten. A very neat type of lubricator is shown. It can be regulated from one up to fifty drops per minute; the oil can be seen dropping, and when the machine stops a little turn-up tap cuts off the supply so that there is no waste, and the trouble of attention is a minimum.



The "Handy" Straightway Valve, worked with Cords.

Besides these things, Messrs. Skudder and Co. exhibit a number of excellent belts of various material. A special kind adapted for dynamos is their raw hide belt. These are cut with the grain of the leather, and are not tanned, but heated chemically for about four hours. They are said to last longer than tanned belts. A 10in. raw hide belt, which was on view, has been sold for driving a dynamo in the North of England. Tanned leather belts of excellent quality are also shown, as well as a number of camel hair belts. These latter are very pliable, and are recommended for exposed and damp situations, or for open air work generally. The whole exhibit by Messrs. Skudder and Co. is very interesting from an engineer's point of view.

THE

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CONTENTS.

THE TELEGRAPH BILL AND TELEPHONES.

Two or three things have for the moment directed renewed attention to telephony in connection with telegraphy. There are in the first place the letters of the Duke of Marlborough and General Webber to the *Times* last week. The first of these is an exceedingly clever production from an exceedingly clever man—inasmuch as it is an excuse for what many would call a retrograde movement. The Duke and his colleagues, the promoters of the New Telephone Company, started a crusade against the men in possession, and up to a point seemed about to carry off the honours of war. A large number of telephone subscribers, in London at any rate, attracted it may be by the promise of cheaper rates and a better service, signed on to the New Company. When affairs were ripe and the prospectus was issued we were all surprised to find our old friends—or if you prefer it our old enemies—pulling the controlling wires. The situation is a queer one, but it has to be faced. To the ordinary onlooker what will happen is this: the New Company will hand over the work to be done to the already organised company and its staff of workmen. New twin-wire connections will be made by the old company's staff, and gradually the whole London system will become a twin-wire system. The combined boards will be found inconvenient, amalgamation will take place, and the ultimate board will consist of those who are cleverest in making their power felt. The Duke of Marlborough had two things to consider in his letter, at least, two important questions; the first was to point out the dangers of competition—dangers which had not occurred to him till he had gained his point and position—then he had to play for a fall as to rates. The New Company's subscribers have signed on under certain rates and conditions. It is evident there will be an attempt to modify these conditions. This is gathered from the sentence "As to the matter of rates, this question produces some difficulty to determine *at present* (the italics are ours), owing to the Government having established a system of telephone uses which will necessitate sound consideration on the part of the companies before establishing their new scale of charges." But the National Company was in the position of being able to modify its charges owing to the new conditions—those charges having been arranged under old conditions, while the New Company's proposed charges were made having the new condition of things in mind, and, in fact, while advocating the Government taking the trunk lines. To us it seems that a combination of interests having been effected, the New Company will go back on its promises, and a scale of charges higher than those contemplated three months ago will be brought into force three months hence. Under the circumstances, we have no hesitation in saying that no single subscriber is legally bound by having signed a requisition to the New—that is, if the latter change their promised plans. We frankly acknowledge that we have been completely bamboozled by the action of the New Company, because the outlook at the commencement of their work seemed to point to "efficiency with economy."

As things have turned out, there is no certainty of either. It is well known, however, that our sympathies have always been in the direction of a government monopoly, and we only accepted the competition of the New Company as a *pis aller*. We are as convinced as ever that the Government ought to, and in the long run must, take over the telephones. The combined interests know this as well as anybody, but they are in this unique position, they can hurry up or delay Government action at their own sweet will. If they give us an efficient and economical service their years of existence are very short, because such a service means so large an increase of subscribers that the telegraph return must suffer considerably, and too much public money is locked up in the telegraphs to allow too great a loss. If, however, the telephone service is but moderately good, the telegraph service will just go on paying its way without interest on capital, while year by year the capital expenditure necessary to take over the telephones will increase, and thus induce Postmasters-General, Chancellors of the Exchequer, and Governments, to put off the evil day.

We have left ourselves but scant room to call attention to the special report and report of the Select Committee on the Telegraphs Bill, which together with the minutes of evidence has just been issued. The cost of report and evidence is only fourpence, so that anyone interested in the subject can easily obtain a copy. One or two of the questions relating to the future action of the department were of an insidious character. Mr. Summers suggested that taking over the trunk lines made it evident that the Post Office thinks it desirable the State should take over the telephonic system, to which Mr. Lamb did not disagree, nor to the suggestion of Mr. Shaw Lefevre that taking over the trunk lines was a long step towards the ultimate end. The evidence of Mr. Lamb before the Committee shows that the permanent officials regard telephonic competition as partly at any rate accounting for the falling off in telegraphy. Our argument has always been that if the amount of royalties paid by telephones equalled the estimated rate of increase that should be received from telegraphs, the Government might well hold their hand. Mr. Lamb, in his evidence, said the amount paid on royalties was "A little more than £40,000 for the last year." He gave the gross figures of the revenue of the telegraph department for the year up to March, 1892, as £2,542,200. Mr. J. Staats Forbes in his evidence gave the number of telephone messages as 160,000,000, "at an average cost to the public of a little over one halfpenny for each communication." Say the 160,000,000 verbal messages brought £350,000, which is little over halfpenny per message. Out of this the Government got a little over £40,000. We contend that through not working the telephone system and getting only royalty, the Government lost at least another £40,000, and will continue to lose this and more every year. In the long run some government will be forced to buy the telephone system at a ruinous loss, for telephony having then practically superseded ordinary telegraphy, the capital spent on acquiring the telegraphs must be added to the capital spent on acquiring the telephonic system, or the nation will have to put down the millions spent in acquiring the old telegraph system for which they have received little interest as lost—a not very pleasant prospect.

REVIEWS.

"Electric Lighting for Marine Engineers," by SYDNEY F. WALKER, M.I.E.E., Tower Publishing Company, London.

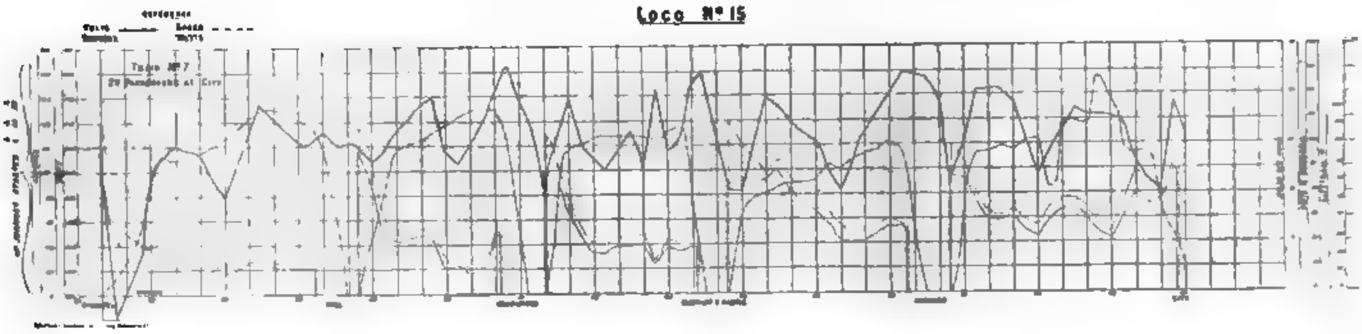
This is a special book with a special object—viz., to instruct marine engineers in the rudiments of electrical work. It is necessary for completeness and for lucidity to give a good deal of information in such books as bears upon the subject generally, and not upon the one branch specially. In this last decade of the nineteenth century we must complain when a book is issued without an index. The table of contents may be full, as in this case, but an index is always required. The book before us is written in a manner and with a method that should commend itself to readers. The preliminary chapters deal with the terms used in considering the subject, with dynamo machines, with cables, wires and wiring, lamps and fittings, switches and cut-outs, and the various details connected with these subjects, as well as with measuring instruments. We imagine, however, that the chapters on faults, or causes of failure and how to remedy them, the use of electric light on petroleum ships and on cargo ships, as well as the information about search lights, will be most appreciated by the class for whom the work is specially written. As a rule, the marine engineer takes charge of the complete installation, and has nothing to do with the actual work of installing the plant, though, of course, in order to maintain it properly it is best to have some idea of the whole work. It is becoming common now to have a spare armature in case anything goes wrong with that originally in the dynamo. In his chapter on "Faults, etc.," which may be taken as a sample of the whole book, the author commences by pointing out the faults likely to arise, and how they may arise. We have then the search, the finding the fault, and when possible the method of remedy. With regard to the safety of the electric light on board petroleum ships, we take it that it is agreed that no light can be absolutely safe, but that the electric light properly installed and carefully maintained is safer than any other illuminant. We believe the marine engineer will welcome this book.

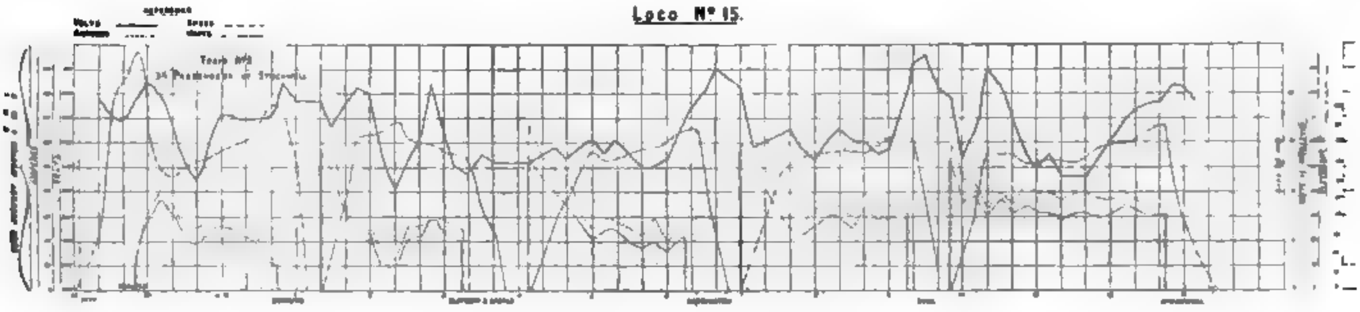
VENTILATION OF BILLIARD SALOONS.

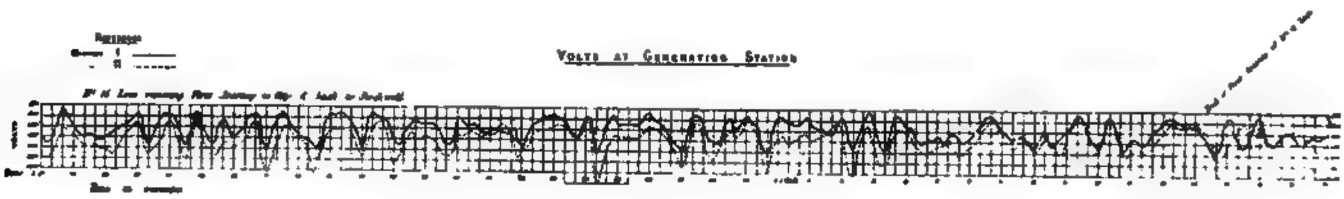
The beneficial results and usefulness appertaining to this branch of the electrical industry is one of such considerable importance, not only to central station managers (desirous of increasing revenue account), but also to the proprietors of billiard saloons, as well as to their customers desirous of playing in a healthy and purer atmosphere, therefore, under these circumstances, we take pleasure in calling special attention to a new alternating current electric blower, which is being placed upon the market by Messrs. Shippey Bros., who are now so well known in connection with small motor work.

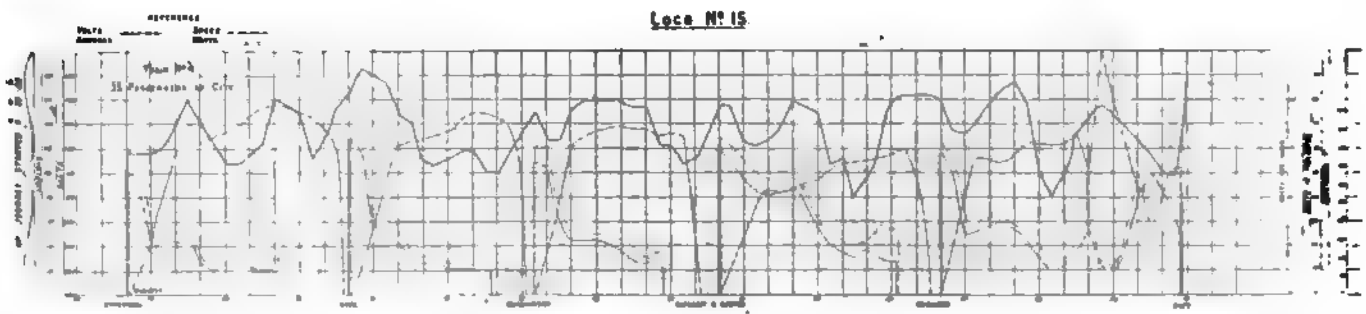
It has come within our province to recently inspect one of these new type of electric ventilators, which appliance has been specially designed by Mr. Arthur Shippey, in order to carry out the objects in view. The revolving fan is entirely enclosed in an outer case, and is arranged for fixing either to or outside of the walls or windows of billiard saloons, smoke-rooms, etc., and by a specially-constructed switch the brushes can be easily reversed by pulling a chain, so that it can be either used as an exhauster of foul air or utilised to suck in fresh air according to requirements. The one submitted to our inspection has been specially constructed to work on alternating currents, and is supplied in three useful sizes of 12in., 18in., and 24in. blades, and in three windings to suit the leading alternating current systems at present in vogue in this country and abroad. The motor has self-oiling bearings, and is also fitted with an

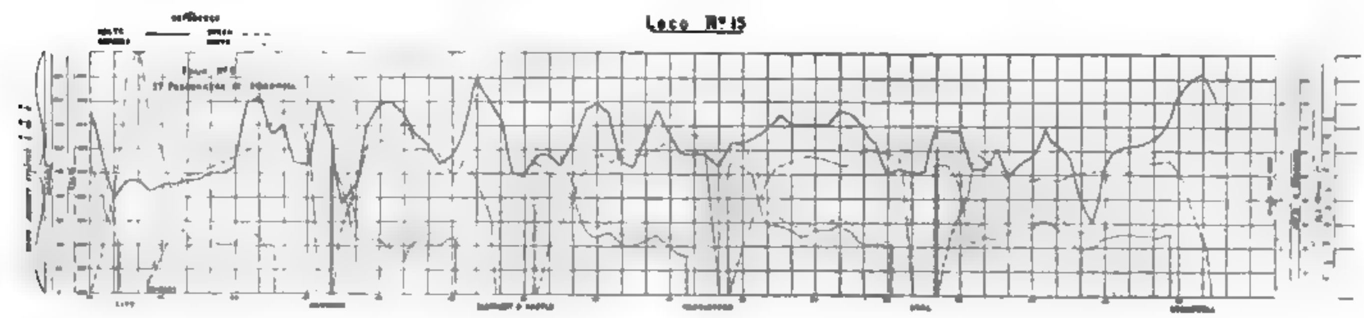
ingenious arrangement for constantly cleaning the commutators from dust, etc., a plan which greatly tends to prevent sparking and the wearing away of same. We have not tested the efficiency or actual working results, but are told they are good. However, we are promised a ventilator for this purpose very shortly, when we shall take the opportunity to place before our readers fuller particulars and drawings of this ingenious little appliance, which is well made and has every appearance of doing good work, and one which we think is destined to assist in the sale of electricity, especially in districts where current is obtainable at a reasonable price.

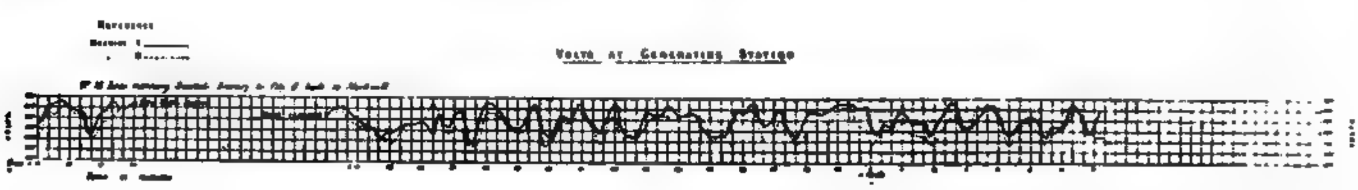






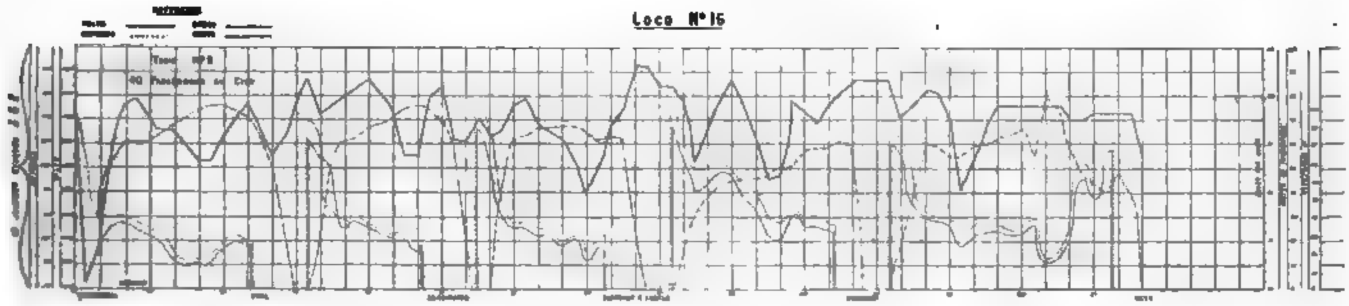


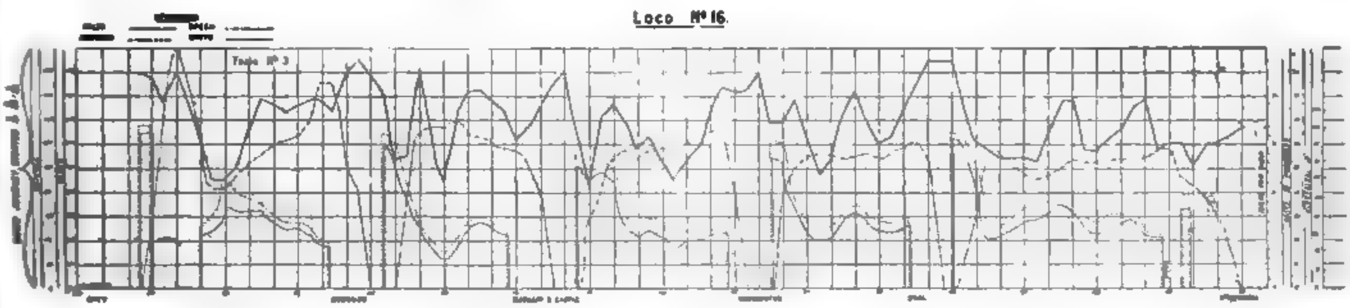


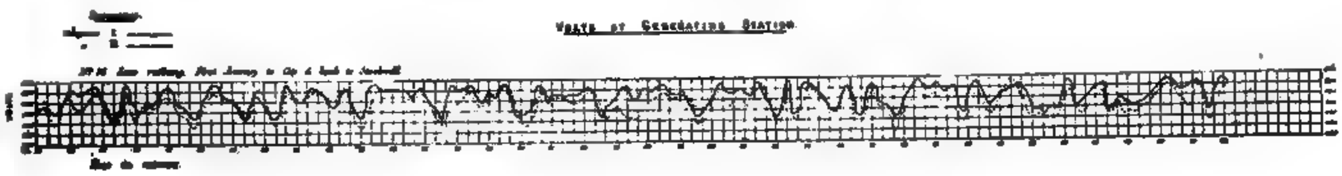


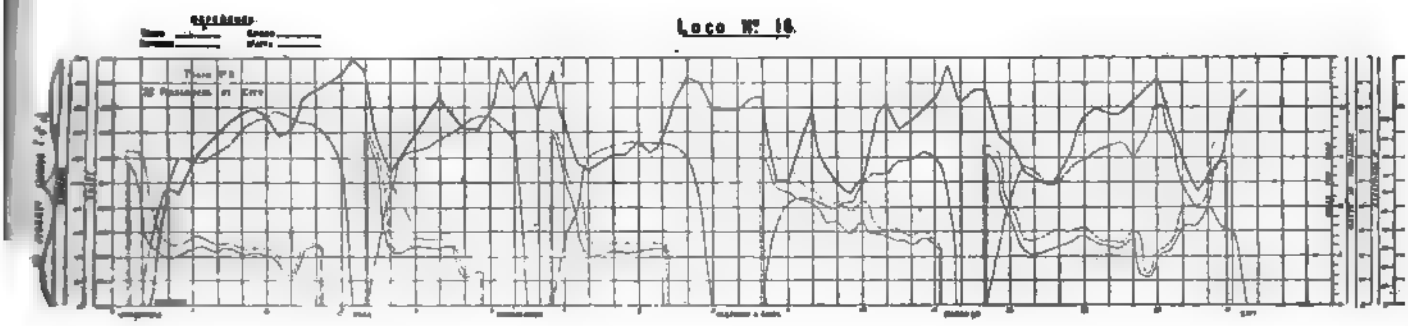
ELECTRIC LOCOMOTION: SOME RESULTS IN ACTUAL WORKING.

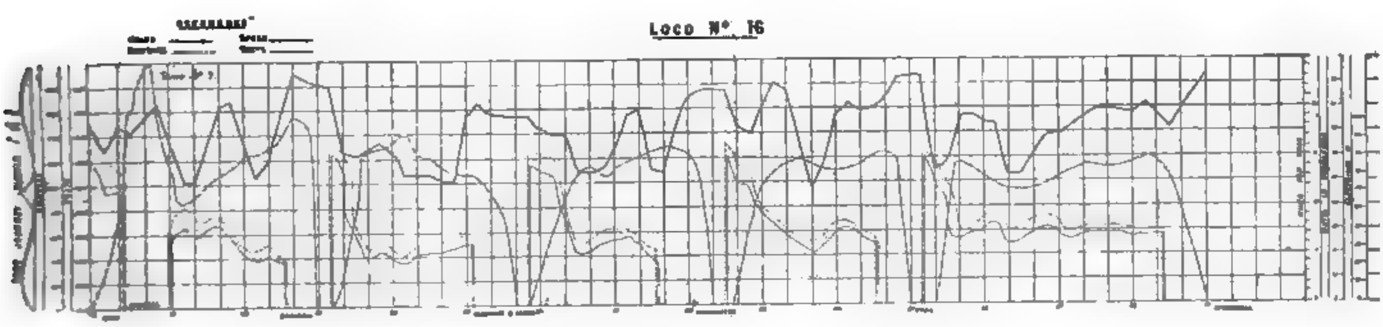
BY ALEXANDER SIEMENS.

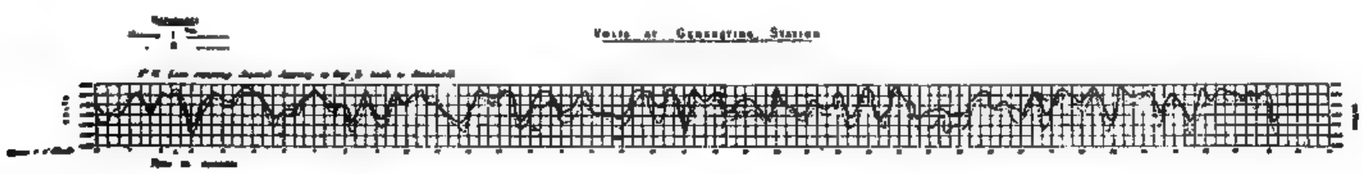












Owing to an oversight the curves were omitted which illustrated Mr. Alexander Siemens' paper, as given in our issue of August 12, and which was read before the British Association at Edinburgh. We now give them on this and opposite page, so that our readers may have the paper complete.

LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

I.—EVOLUTION OF ELECTRICAL ENGINEERING.

THE FIRST ELECTRIC LIGHT.

It was on one evening in the year 1810 that Sir Humphrey Davy showed to a large and distinguished audience, assembled at the rooms of the Royal Institution, the brilliant and dazzling light that was produced by passing a current of electricity through two pencils of charcoal, about an inch long and one-sixteenth of an inch thick, the said pencils being placed end to end, and slightly separated from each other. This is generally conceded to have been the first time that the world saw the electric light, hence we may date its birth from the above historical event.

DISCOVERY OF DYNAMIC ELECTRICITY.

In those days the only available source of electricity was the primary or voltaic cell, and to obtain any large quantity of electricity a great number of these had to be used. A number of cells connected together forms a battery, probably so named after the example afforded by calling a number of field-guns a battery. The battery employed by Sir Humphrey Davy consisted of 2,000 Grove cells, so some idea can be formed of the great trouble and expense incurred in handling such a quantity. A voltaic cell, as most people know, consists of two different metals put into a glass or porcelain jar, the jar being divided by a porous partition, and filled with acidulated solutions. A wire is fixed to each metal plate, and when the two free ends of the two wires are joined together, so as to form a complete circuit, then a current of electricity will flow, the strength of which will depend on the size and nature of the metals, and the kind of solution, etc. In the particular type of cell, known as Grove's cell, the two metals consist of zinc and platinum, the zinc being put into a solution of sulphuric acid and the platinum into a solution of nitric acid.

It was reserved to the genius of Henry and Faraday, those two seekers after truth, to disclose to the world the great discovery that magnetism could produce electricity a discovery that is justly classed as one of the most important that man ever made.

The honour is equally divided between the two above-named men, each was working patiently and laboriously to find the link between electricity and magnetism—Henry in the New World, amidst his busy work-a-day duties of teaching at Albany Academy, New York State, snatching, when he could, a few spare moments to spend on his absorbing experiments. Faraday, in England, with ample leisure and scientific facilities of every description at his command, occupying, as he did, the position of chemical professor at the Royal Institution. Each was working independently of the other, and made the long wished for discovery independently. In point of time Henry was the first to reach the goal, August, 1830, being given as the time of his decisive experimental proof, while Faraday arrived at the same ends in September, 1831, ignorant of Henry's work.

And now to set forth the nature of this momentous discovery. Prior to this time it was known that when a current of electricity was flowing in a conductor or wire it would deflect the needle of a compass placed near to the wire, showing that the electric current acted magnetically by deflecting or attracting the needle Henry and Faraday discovered the converse of this, i.e., that magnetism could produce an electric current. When a piece of iron is magnetised its two ends are named the "poles", when the iron bar is bent into the shape of a horseshoe its two ends are brought near together, so that both the poles can exert their power jointly, from one pole of the magnet a stream of what has been named by Faraday "lines of force" issue, and re-enter at the other pole, in the case of the horseshaped magnet, the lines curve across the air gap between the two poles, and the space which these lines of force occupy is named the "magnetic field" these lines of force, of course, are only imaginary, like the Equatorial line, but they serve to illustrate very clearly the direction of the magnetic forces. When the ends of the magnet do not face each other the lines curve round in issuing and entering. If a length of wire or metal conductor, whose two ends are joined so as to make a complete circuit, be caused to move across the magnetic field, so as to cut through, so to speak, the "lines of force," then a current of electricity will be generated in that conductor, and will last so long as the movement of the conductor lasts in the magnetic field. The same effect will be produced if the wire is stationary and the magnet be caused to move. This, then, in brief, is the fundamental principle upon which all dynamos work, and without the possession of this it is safe to say there would be no electric lighting as it is to-day.

EVOLUTION OF THE MODERN DYNAMO AND LAMPS.

For some considerable time the dynamo was confined to the laboratory, and looked upon as a scientific piece of apparatus, scientists little dreaming what a future it had before it. The first practical form which the dynamo assumed was that brought out by Dr. Werner Siemens in 1867, and during the subsequent 10 years many keen minds were hard at work improving it, and gradually bringing it into shape, electrically and mechanically.

Naturally the next article that claims our attention is the electric lamp, the adjunct to the dynamo, the evolution of which was slow and gradual, like the dynamo When a current of electricity is passed through two pencils of charcoal or carbon, slightly separated, these slowly consume away, and the carbons used to be fed forward by hand, this primitive method was supplanted by automatic feeding, effected by clockwork. The first arc lamp of real practical value was designed in 1857 by Serrin, who caused the electric current to regulate the lamp automatically. After this rapid improvements appeared, resulting in the excellent types of to-day.

Turning now to the glow or incandescent lamp, early experimentalists first used platinum wire sealed in a glass bulb, filled with non-combustible vapour. Upon sending a current through a thin piece of metal of high resistance, like platinum or iridium, it is raised to a white heat, the brilliancy or intensity of the light emitted depending on the quantity of current, this is the principle of the incandescent lamp, and since the metal would consume away in the atmosphere it was necessary to place it in a non-combustible vapour, such as nitrogen. Through the invention of the air pump, however, a new field presented itself About 1878 Prof W Crookes made a series of valuable experiments on the vacuum tube, and conceived the idea of making incandescent lamps by placing the thin metal thread or filament in a glass bulb exhausted of air

Simultaneously, we had Edison working in America, and Lane Fox and Swan in England, each striving to evolve a practical glow lamp, each was successful, and at about the same time. Edison and Swan put the fruits of their labour together, and then was created the famous Edison-Swan lamp, consisting of a thin curled thread of carbon sealed in an air-exhausted glass bulb.

ELECTRIC LIGHT MANIA OF 1881.

We now reach the year 1881. An electrical exhibition at Paris, and a subsequent one at the Crystal Palace in the following year, gave the public opportunities of examining and criticising the new illuminant. Mind, at that time there were no self-regulating devices, no proved method of distributing the electric current, no arc lamp that could be counted on to burn for five minutes without spluttering and going out, no serviceable storage battery and lastly, no expression of surprise if the lights suddenly went out at any moment. The dynamo was in a very crude state, the same with the arc lamp, and very little knowledge existed in fixing wires but all this the general public could not see, and at that time the electricians did not either. If the public, and those interested in showing that public how to make its fortune in a day had left the electric light alone, all might have gone well, but the financial wolf was abroad in the guise of the company promoter, seeking whom he might devour Due probably to the success that had attended the pioneers of electric lighting, the most exaggerated and chimerical notions were spread abroad as to the miraculous feats electricity was going to perform, a mania arose, companies were formed by the dozen, the gulled public bought shares expecting to make

their fortune, gas was looked upon as a thing of the past, and a temporary panic was felt in that quarter. Electricity was going to be used universally, and to supersede gas entirely, and shares in these bogus companies rose rapidly. In fact, the public were blinded by the dazzling effect of the electric light!

Then came the awakening, the breaking of the bubble, and all the castles in the air vanished, demolished by hard facts; but the disappointment of the public did not vanish quite so quickly; it is remembered to this day. The result of this failure can be easily explained. The electric light was only a laboratory experiment then, and everything, as before mentioned, was in a very crude state; particularly, suitable apparatus for controlling the light automatically; the compounding of dynamos was unknown, and lights could not be switched off and on in various quantities, unless there was some manual aid to keep the lights at their proper brilliancy.

SUBSEQUENT PROGRESS.

During the last few years invention has been going on at a very rapid rate. The most eminent scientists and physicists of the day have given their minds to the task, and have diligently laboured and experimented in the laboratory. Bit by bit, piece by piece, has the edifice of electrical science been built up. One man's mistake was another man's luck, defects were rooted out one by one, and no sooner was one thing accomplished than another man tried to improve it. The man of science was, however, not sufficiently backed up by practical aid. The early electricians did not exhibit good mechanical construction in their apparatus; they were ignorant of the forces with which they had to deal; in one word, they did not treat electricity as electric horse-power. Dynamos were built too weak; there was no mechanical design about them; a piece of string used to be put where a piece of steel wire is now put. It is now thoroughly understood that a dynamo, or any other electric machine which produces power, must *à priori* be designed and built in a strong and substantial mechanical fashion, just the same as a steam engine is built. The electrical engineers of to-day have taken this to heart very thoroughly, for their education and training requires a good knowledge of mechanics as well as of electricity.

It may in truth be stated that the latter half of the Nineteenth century will be famous as "The Electric Age," and will mark the development and application of a new and mysterious force, which has been tamed and harnessed through the indomitable energy of man to a thousand and one uses, benefiting all humanity. A force which does its work silently and swiftly, yet giving no sign of its presence; a force subject to the greatest elasticity in division and sub-division; and a force which in process of time will probably be called upon to be the universal slave of mankind, ready at a moment's notice to do his bidding, by land or sea, in the toiling city, or in the solitude of nature; another secret wrested from nature, signalising another triumph of mind over matter.

(To be continued.)

THE EFFECT OF FRICTION UPON THE EXACTITUDE OF ELECTRIC METERS.

BY G. P. ROUX.

The question of electric meters becomes every day more and more important as the developments of the distribution of electrical energy increase, but among the numerous systems of meters which have been brought forward, up to the present there are few which have given satisfactory results.

As in every mechanical apparatus set in motion by any means whatever, there are necessarily in every electrical meter rubbing contacts and friction. The friction arises from a number of causes—want of oil, bad lubrication, dust, abnormal expansion of certain parts, inconstant resistances of the dial wheels, resistances produced by the air upon certain pieces in rotation, friction of brushes and pivots, wear and tear, and so forth.

By reason of their very nature these frictions are not constant, and vary from day to day even in the best constructed instruments. They can in no case be considered as invariable, whatever may be the ingenious arrangements employed in the construction of pivots, gearings, etc. They may be reduced, but they cannot be guaranteed constant.

In the construction of electric meters sufficient attention unfortunately has not been paid to this important factor—the variation of friction.

Without examining in detail the solutions proposed, I will in a few words breifly describe the different electrical principles which have been employed in the construction of electric meters.

The product to be measured is the electrical energy expended in any circuit and in a given time, which may be expressed thus: E, I, T (volts, amperes, time). It is supposed in certain instruments that one of the factors, E or I, remains constant, according to the circumstances, and the measurement is carried out on E T or I T only, according to whether the distribution is at constant potential or constant current, the first case being the more generally employed.

Meters measuring energy must always be taken as the most exact as taking into account the variation of all the factors, E, I, and T.

A single class of meters are capable in theory of measuring directly and surely the quantity I T of electricity passing through them. These are the chemical meters, the first kind of meter, I think, ever constructed.

These meters are composed of an electrolytic bath, through which is passed either the whole of the current to be measured, or a certain portion taken in shunt from the extremities of a constant resistance. This latter arrangement has been employed by Edison, but if it has the merit of excluding all mechanical movements, its use is very inconvenient and its accuracy more than doubtful. The reading of the meter takes place by measuring the change of weight of the electrodes. This weight evidently represents the quantity of current which has passed through the meter, but the relation of this quantity to the total current is absolutely unknown, because of the variation of the resistance of the liquid in the electrolytic bath, its counter E.M.F., etc.

There has recently appeared another chemical meter, that of MM. Desruelles and Chauvin, which is traversed by the whole of the current to be measured. The electrodes, which are of large surface, are mounted upon a kind of balance beam which, by means of suitable mechanical and electrical arrangements, is made to reverse the current in the meter each time the weight of the electrodes varies by a determined quantity. The gear of the registering apparatus is advanced one place at each oscillation.

We may object in this meter to its complication, which is considerable, and to the certain destruction of the plates at a more or less distant time, and also to the loss of electrical pressure it necessarily produces in the mains by reason of the counter E.M.F. of decomposition, which must at least attain to one volt.

Pass now to the mechanical meters. These may be classed into two large distinct categories: discontinuous integration meters, and continuous integration meters.

The first, of which there are a large number, are composed essentially of a measuring apparatus (voltmeter, ampere-meter, wattmeter) arranged on the circuit to be measured, and a clockwork movement, coming into play at regular intervals to move the gear of a dial counter a certain extent, according to the deviation of the measuring instrument, and rendered, by means of suitable arrangements, proportional to the current.

These instruments are capable of a high degree of precision, but their mechanical complication is almost always very great. Their gravest defect arises from the fact that the clockwork and consequently all the gear and parts of the meter are set in movement as soon as the circuit is connected, even when there is no consumption to be measured. The wear and tear is, therefore, very great, and the instrument requires considerable attention to keep it in working order. The continuous integration meters, or motor meters, are based upon an entirely different

principle. They are composed essentially of two parts connected firmly together: (1) some kind of motor traversed by the current, E I, to be measured, arranged so as to produce a motor couple, K C, proportional to this current; (2) some kind of brake—liquid, magnetic, or other—producing a resisting couple, K′ F V, proportional to the speed of the motor.

I will also mention, for the sake of not overlooking it, one meter which does not belong directly to either of the above classes—namely, the Aron meter. This measures the current by the advance made by one clock having an ordinary pendulum, over a second clock whose pendulum is influenced by coils in circuit with the current to be measured. A differential movement indicates directly the expenditure of current. Besides the inconvenience of winding up the clockwork of this meter by hand, its great defect is the practical impossibility of obtaining synchronism of the pendulums when no current is passing, so that the meter continually adds or subtracts when running light. The attempt has been made to remedy this defect by connecting the two pendulums by a loose thread, in the centre of which is hung a small weight of about one gramme, to force them to beat in unison when free. But this arrangement has evidently the effect of preventing the registration of small currents.

The future seeming to be reserved to the motor-meters, let us examine what is influence on the exactitude of this class of motor caused by variation of friction in their gearing.

We have seen, theoretically, that these instruments must take constantly a speed proportional to the current passing through them. We can therefore establish by the following equation the condition of equilibrium of the system, by saying that the quantity of work furnished by the motor is equal to the quantity of work absorbed by the brake and the friction of the apparatus. That is

$$K V C = (K F V) \times V + \phi V.$$

If it is admitted that ϕV is negligible, that is to say, the friction of the instrument is *nil*, we can say

$$K \times C = K' \times F \times V',$$

whence $$C = V \times \frac{K}{K' F};$$

that is, the current is proportional to the speed.

But these motors being very weak, and having to overcome the friction of pivots, brushes, gearing, it results therefrom that the speed of equilibrium is modified to a greater or less extent, by the presence of these accessory resistances, which are themselves susceptible of variation, and which will consequently cause a variation in the factor, ϕV. The factor has, it is admitted, a certain value of which account is taken in the calibration, but what is not allowed for is the modification of this factor from time to time by the working of the instrument.

The foregoing formula, applying to all the motor meters, it is seen that their exactitude is constantly modified and influenced by the variations of the factor, ϕV, and the variations in the calibration may, according to the cases taken, attain to 10, or even as high as 15 per cent.

There exists one meter upon a new principle which escapes this criticism, the only one I believe which does so, I mean the Brillié meter.* M. Brillié in his meter, at the risk of making the apparatus somewhat complicated, has made it his principal aim to solve this problem of friction variation; and it may be said from the result of the numerous tests which have been made, and from the theory and the principle itself upon which this instrument is constructed, that he has thoroughly succeeded.

The problem has been solved in a very simple manner by the complete separation, the absolute independence, of the measuring instrument from the registering apparatus or motor. The electric measuring instrument is not itself a motor, but a simple electro-dynamometer acting merely as a speed regulator to a small motor, which actuates the gearing and dials of the meter. The advantages which result from this arrangement are as follows: (1) There is at disposal, consequent upon the employment of an electro-dynamometer, a strong effort from a small current, it being possible to wind the coil with many turns, and all the turns being in the position of maximum effort with regard to the coils of the fixed coil. (2) The efforts to be overcome by this measuring instrument are reduced to a minimum. (3). The indications of the meter are rendered independent of the friction of the gear in movement, the speed of this latter being regulated by the electro-dynamometer in the same manner as a steam engine is regulated by its governor, the speed being thus rendered entirely independent of the load.

The movable fine wire coil is suspended by a silver wire, sufficiently long and thin for its torsion to be neglected, especially if the small angle of deviation of this coil be considered, as the deviation is of a few degrees only, and the maximum deviation corresponds exactly with the maximum effort exercised by the current. The torsion may be thus considered as negligible, and the movable coil may be considered as suspended freely on the field of force formed by the passage of the current in the main ribbon coil.

We can, therefore, say that the effort a exercised by the quantity of electricity passing is equal to

$$a = (E I) - t,$$

in which a = effort exercised by the product of
E = volts, and I = amperes, and t = opposing torsional force of the silver wire.

We have seen that this effort t may be neglected and considered as nil, being in practice absolutely negligible.

We can, therefore, say

$$a = E I.$$

By the construction of the meter itself and the principle of the wattmeter coil, the friction usually present in the electric meters is *nil*, and in reality does not exist. The variations in friction of the motor part of the apparatus, which is completely separated from the measuring part of the apparatus, cannot possibly have any effect whatever upon the value a, which will be always equal and proportional to E I. Nor can it have any influence upon the registration, as we shall show.

The integration of the quantities of electricity, or, rather, the effort a, is brought about by an electromotor putting in motion on the one hand a train of dial wheels and on the other hand a set of permanent magnets generating Foucault currents in a copper disc.

Numerous experiments carried out upon Foucault currents, produced either by the rotation of a disc in a magnetic field or by the rotation of a magnetic field over a fixed disc, have demonstrated that the effort developed is directly proportional to the speed of rotation. Consequently we can say that the effort b exercised upon the copper disc is equal to

$$b = [V(8 M)] - R_1 \ldots R_n,$$

in which b = effort exercised by the speed, V, of rotation of the magnets possessing a magnetic field, M, their number being eight.

From experience and in view of the special quality of make and the progress realised in the manufacture of magnets, we may consider their magnetic field as remaining constant. The value, 8 M, is therefore constant.

On the other hand, the resistance, $R_1 \ldots R_n$ will alone influence the speed of rotation of the magnets turning under the impulse of the motor, consequently it is the motor alone which will be influenced. Now, as the speed, V, is obtained by the value of the energy, $e\,i$, passing in the motor, we can say therefore:

$$b = (8 M) \times [e\,i - (R_1 + R_2 \ldots R_n)].$$

This granted, we will examine how the system behaves when a variation of friction resistance occurs.

We have seen that the copper disc is connected firmly with the movable coil of the wattmeter, and that the effort exercised upon this latter takes place in an opposite direction to the effort exercised on the copper disc by the rotation of the magnets.

Suppose, now, there is an increase of friction in the gearing or other part, we have seen above that the effect of this would be to diminish the speed of rotation of the magnets, and therefore the value b, consequently the

* A full description, with illustrations, of this meter was given in the *Electrical Engineer* for June 17th, 1892, pp. 596-7.

equilibrium which existed between the two efforts a and b, will be destroyed, and we shall have

$$E\,I > (8\,M) \times [e\,i - (R_1 + R_2 \; . \; . \; . \; R_n)];$$

whence, $a > b$.

The value a being greater than the value b, the movable coil of the wattmeter will deviate under the preponderating action of E I, and will draw with it the regulating resistance of the motor circuit (to which, in the Brillié meter, it is connected), the effect of which will be to increase the current, $e\,i$, passing through the motor, and thereby giving it sufficient power to overcome the increase of friction resistance spoken about; the speed, previously diminished, will now increase until equilibrium is again established—that is, until a is once more equal to b, which will occur when the speed of rotation has returned to its preceding value corresponding to E I.

Let us now take the opposite case—namely, a diminution of friction. The speed will then increase and the effect produced by the rotation upon the copper disc will also increase, and the case will then stand thus—

$$E\,I < (8\,M) \times [e\,i - (R_1 + R_2 \; . \; . \; . \; R_n)],$$

whence, $a < b$.

The value b being now greater than the value a, the wattmeter coil will deviate under the preponderating action of the magnets, and will draw with it the rheostat contacts, will increase the resistance in series with the motor until the increase of resistance having sufficiently decreased the speed, the effort b has returned to its primitive value.

It is seen, therefore, that in no case can the value b be modified without being followed immediately with a variation in the speed of rotation of the magnets so as to bring it back to a point at which it again equals the value a—that is, to maintain the speed constantly proportional to the current to be measured. We can therefore conclude that this meter carries out thoroughly the conditions demanded—viz.:

$$W = \int^t E\,I\,d\,T;$$

in other words, that it is really what it pretends to be, a meter of electrical energy.

From the foregoing it is seen that any variation of friction in the parts of the Brillié meter will have no influence on the meter registration, but solely upon the value $e\,i$ of the small current required to drive the motor.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.*

BY PROF. GEORGE FORBES.

LECTURE I.—INTRODUCTORY.

In 1885 I had the honour to deliver a course of lectures here on the "Distribution of Electricity." This followed a long paper I had read to the Society of Telegraph Engineers on the "Heating of Conductors," when I got out tables for practical electricians of the sizes of wires to be used with different electric currents to prevent over heating. Up to that date the distribution of electricity had been but little studied, and numerous serious mistakes were being made. My object at that time was to lay down in clear language the scientific conditions which must underlie any scheme of distribution. At that time, the more modern plan of using high tension alternating currents was hardly developed, and the advocates of high tension were engaged on storage batteries, and on various parallel series systems, which introduced the high tension actually into houses.

When I arrived at the conclusion that, for a central station supplying 100,000 lamps, the copper conductors leaving the central station must, on the most economical principles, be equal to two cylinders of copper, each equalling the thickness of a man's body, it seemed that low tension was doomed.

No single invention of any importance has added to our facilities in low-tension distribution, so as to affect the dimensions of the conductors, and yet low-tension distribution has done much solid work on a large scale. When asked by the council of the society to give a course of Cantor lectures I felt that at the present date, I could not do better than supplement my previous course, and bring my work on electrical distribution up to date; and it will be well also to examine the reasons why the objections which formerly existed against low tension distribution have so far been overridden that millions of pounds sterling have been invested in it.

* Cantor Lectures delivered before the Society of Arts.

The present course of lectures is intended primarily for electrical engineers, and it is to them that my principal remarks will be addressed, but there are many present who have no intention of putting what they hear to practical use, and it will not be out of place if I indicate briefly some of the points that have to be attended to in electrical distribution.

The resistance offered by conductors to the electric current causes two sources of trouble. One is that energy is absorbed and wasted, and this may seriously affect the coal bill and the total machinery required in the central station. The solution of this difficulty is naturally to reduce the waste by reducing the resistance of the conductors. This means that we are to use larger copper conductors. But this increases the cost, and it is clear that there is a definite most economical size, such that, if the conductors are increased in size, the increased interest on capital expenditure swells the cost; and if we diminish the size, the extra machinery required increases it, and the coal bill rises. It is an important function of the electrical engineer to determine in every case this most economical size of conductor. Large experience has generally led to finding the most economical size to be such that the current density shall be not more than 500 amperes per square inch. The other trouble is that when many lamps are in use, and a large current is flowing, the electric pressure is reduced and the lamps are dim. The further distant a lamp is from the central station the lower is its pressure, and the difference in brightness of lamps is particularly observable in the distant lamps. Those near the station suffer no loss. To increase the brightness of distant lamps during the busy hours, the pressure at the station may be slightly raised. Thus we generally find in central station distribution that in the busy hours lamps near the station are brighter than usual, and the distant ones are more dim. This is well shown by diagrams of pressure taken on different parts of distribution mains by self-recording apparatus. This solution of the trouble does not go far, however, as we cannot allow a large variation of pressure in any lamp. The Board of Trade at present allow the large fluctuation of 8 per cent., and it is to be regretted that the supply companies generally avail themselves to the full of this latitude. This is shown by recording voltmeters.

For further improvement in the supply it is necessary to introduce feeders, which are conducting wires going from the central station direct to certain points on the network of distributing mains, where the variation in volts is found to be large. No lamps being connected on to the length of these feeders, the full pressure can be supplied at the point of distribution without other lamps being raised in pressure.

I do not intend to pass further in review the general principles of low tension distribution. The problem and the rules to be followed were completely worked out in detail in my previous Cantor Lectures; and after these last seven years of busy work, I have not one word to alter in all that I said at that date.

Nor have I the intention in the present course to do what might be an interesting proceeding—viz., to describe the various central stations which have been erected in these years, and analyse and criticise their modes of working. Some of the stations with which I have myself been connected as consulting engineer have been low tension and some high tension, and it might have been thought desirable that I should give you the results of my own experience. Moreover, as is well known, I have largely devoted myself to a careful study on the spot of a large proportion of the central stations both in Europe and America, and I might easily have found materials in this experience to occupy a few evenings with profit. I have, however, other aims in these lectures, and descriptions of central stations are not wanting to those who are sufficiently interested in them. I have myself given full details of the

machinery and methods employed at some of the great European stations in a paper read before the Institution of Electrical Engineers in 1889. A very interesting account of central stations in Germany, by all the best manufacturers, was brought out in a handbook published last year at Frankfort for the Exhibition.* My desire is to carry into these lectures the same spirit that led to my previous Cantor Lectures, and to bring before engineers the points that require attention to make our work as perfect as possible, and to draw attention to the lines in which we may hope to overcome the great drawbacks which still hamper the industry, and prevent it from furnishing such economical results as the general conditions of the problems warrant us in expecting. It will, I hope, be found that there are engineering resources at our call which have yet to be invoked before we have reached the final solution of the problems.

As an example, I will point out to you one or two facts in the economy of the subject. One is that central station distribution, as distinguished from isolated plants, involves a huge additional expense in distributing mains. The cost of these must, from the nature of the case, be out of proportion to their earnings until the consumers are much more closely packed than at present.

Another fact is that our machinery is lying idle three-quarters of the year, and earning no dividend. A third is that, owing to the limited period during each day that the maximum demand exists, we waste fuel in heating up most of our boilers for only a couple of hours' work in the evening. A fourth point is, that owing to the irregularity of the demand, we waste a great deal of steam by working our engines much under their full and economical load.

All these points will be fully elaborated in the lectures. The net result is that electricity in London costs twice as much as gas; that it costs more to obtain it from a public supply than when manufactured (for a large establishment) on the premises; that the method of debiting consumers is unfair on those who have the longest hours of working. You must not be deceived by the optimistic calculations of enthusiasts and interested parties. The electrical industry has nothing to fear from competition, and the surest way of gaining the confidence of the public, and of making sound progress, is to openly accept the true state of the case, and acknowledge the difficulties that hamper you, and then apply all the skill at your disposal to overcome these difficulties. In illustration of the points I have raised, I will here only state one or two points.

1. The streets in London are not lighted generally as they ought to be by arc lights. We know, from a most extensive experience, that anyone can set up a circuit of 10 ampere arc lamps with underground mains, and run them with good profit at a rate of £30 per annum, during all the hours that gas lamps are now used—4,000 hours per annum. The cost of the mere current for these from a supply company, at 7d. per unit, amounts to £58. 6s. 8d., double what it would be if privately worked.

2. A careful comparison of the cost of lighting the Athenæum Club with its own machinery, which has been done for many years, with the charges from a supply company at 7d. per unit., shows that the present cost is £894 per annum, including depreciation on machinery costing £1,608, as against £1,452, which the company would charge us.

We must fairly recognise the fact that electricity is twice as dear as gas, and also that where we replace gas by electricity we must increase our expense in warming a house. When this has been granted, we must remember that we save much in decorating and in preserving our books, that we abolish vitiated and dirty air, and that we can keep our rooms cool. These are sufficient recommendations for those who value cleanliness and health, and will spur the ingenious among us to remove the confessed drawbacks.

In order to perfect our systems of distribution in practice, we must keep before our minds the ideally perfect, and depart from that course only at the gain of decidedly practical advantages, and we shall often find that if due caution is exercised we can gain much by very slight departures from the ideally perfect. This is the spirit which has actuated the evolutionists of the modern dynamo, and which enables us to be proud of our 96 per cent. efficiency, while the steam engine, with a hundred years of brain work and millions of money spent on its development, has reached only 80 per cent. efficiency in its mechanical working. Had it not been for the scientific men who took up dynamo construction at the beginning, we would have rested content with the 50 per cent. efficiency originally offered by Brush and others in machines which were thoroughly well designed mechanically, and did their work thoroughly, if uneconomically. At first, designs of complicated character were introduced, in which the rapidly-revolving parts—those requiring most mechanical strength—contained only the following materials: An iron spindle, a wooden hub, and an armature made of iron wire, wound with copper wire, the parts being joined and separated by millinery and paper and sealing-wax. The object of this construction was to minimise the losses. One weak part after another was discarded, until we now have a fairly strong and mechanical armature.

So in electrical distribution. Ten years ago we searched for the ideally best. In each case we made elaborate calculations of the probable consumption in different parts, and we tried to average the relative size of feeders and distributing mains and their points of connection as accurately as possible. We tried to select those points for attaching feeders that would use the least copper, and we tried to devise means of regulating electric pressure in the feeders, so as to waste no more copper or electric energy than was absolutely necessary.

Ten years of practice in central station working has now stereotyped our practice a good deal; and while we do not always lead a conducting wire by the shortest route from each lamp to the central station, and while we do not always attach a feeder to the nearest part of the district it has to feed in normal conditions, still we always have these leading principles in mind while laying out a plan of electric mains, and we readily adopt the general average results of our experience in past work to simplify our system.

(To be continued.)

* "Die Versorgung von Städten mit Elektrischem Strom."

TRADE NOTES AND NOVELTIES.

LEAKAGE INDICATOR.

A new leakage indicator, manufactured by Hartmann and Braun, has been introduced by their London agents, Messrs. O. Berend and Co. It has the same outward

Fig.

appearance as their ordinary 9in. voltmeter. The difference of potential remaining constant, the readings can be taken direct in ohms. The readings of an earth leakage indicator for a 2,000 volt circuit range from 2,000,000 ohms to 200,000 ohms, and this range can be diminished to any extent—for instance, from 1,000,000 to 100,000 ohms. The instrument has three terminals, one of these being connected to earth and the other two are joined to the mains. By means of a lever handle either of the mains can be connected to earth through a coil in the

instrument. If there is a leak from either main a current flowing through this coil will deflect the needle, and this indicates the result direct in ohms. If the lever be turned to the positive pole it will measure the leak in the negative main, and *vice versâ*. All the parts of the instrument are extremely well insulated, and the coil itself is soaked in paraffin wax. The instrument has been constructed both for continuous and alternating currents, and should prove a most useful addition to central station instruments.

THE HUMAN BODY AS A CONDUCTOR OF ELECTRICITY.[1]

BY H. NEWMAN LAWRENCE, M.I.E.E.

That the human body is no ordinary conductor has been long acknowledged, but the peculiarity of its conductivity and the conditions under which this conductivity varies, are subjects which have hardly yet been satisfactorily investigated.

In a former communication which I had the honour of putting before the association,* I set forth certain observations on the resistance of the body to different forms of current. Since then other observers have published results of their investigations in the same direction, and a reasonable approach to the solution of the problem of body resistance has been made.

In the present communication I desire to take up that portion of the subject which deals with the conductivity of the body rather than with its initial resistance—to see what is the effect of a passage of current after the first resistance has been overcome and to find what are the differences of conductivity in the several parts.

The value of a true knowledge of the conductivity is of scarcely less importance in connection with accidental contacts with light and power circuits than that of initial resistance itself. It may easily happen that by the continued passage of current for a short time, the conductivity may be so improved that a voltage which at first was practically harmless, becomes ample to pass current enough to be fatal.

The experiments herein described were designed to show, first, the effect upon conductivity of the passage of a steady current for a few minutes, and second, to indicate the relative conductivity of different parts of the body after such currents had passed. Before going further, it may be well to glance at the position of affairs regarding the resistance of the body as a whole. Numerous investigators have given the matter their attention, notably Erb,† Lant Carpenter,‡ and Stone,§ and a gradual evolution of the truth has resulted, till to-day we find ourselves, not, indeed, at the complete solution of the problem, but in a fair way to arrive at it. We find that the resistance of the living body is by no means a fixed quantity, at any rate when the skin is included in the circuit. That it may vary from half a million ohms, with small contacts and dry skin, to 540 ohms, with very large contacts and soaked skin, as shown by Dr. Hedley in his recently published book.‖ That its value between extremes depends upon the contact area and the degree of moisture, as shown by Dr. Harries¶ and myself. That the situation of the contacts in relation to the number of sweat glands covered has considerable influence, as demonstrated by Erb†. Further, that this resistance is much greater to continuous currents than to alternating currents, as found by Dr. Stone,‡ who gives the proportion as 2 to 1, and by Dr. Harries and myself,¶ who give the minimum proportion as 1·5 to 1.

Some investigators have concluded or assumed that the whole of the body resistance resides practically in the skin. Erb seems to be of this opinion, for in his work already referred to he speaks throughout of the "resistance of the skin." Jolly says, "the resistance of two layers of cuticle is equivalent to about 300 times that of the remaining tissues when a current is transmitted from one hand to the other."* The extent to which this may be true is yet unproved, I think, though there can be little doubt that a large portion of the whole resistance does reside in the skin when unmoistened.

Various attempts have been made to eliminate the skin resistance altogether, and so arrive at that of the tissues only. Carpenter, by means of soakage in salt and water for 60 minutes, arrived at a point beyond which the total resistance would not be reduced. Stone, by similar methods, claimed to have found the true body resistance; but in both cases the conclusion seems to have been more assumed than proved.

Waller, in his recent valuable work on physiology,† gives the resistance of the skin as from 1,000 to 100,000 ohms, according to moisture, but does not accompany the statement with any particulars of how the figures were arrived at. Does he mean one or two layers of cuticle? Was the skin cut out, or in any way separated from the body? What was the contact area? Did he intend his figures to refer to the whole body resistance, on the ground that the portion due to substances other than the skin is so small as to be negligible? The absence of these and similar particulars is much to be regretted, and without them one hesitates to use the figures as a basis for other calculations, even though coming from so eminent an authority on matters physiological. My own observation goes to show that not only the skin resistance, but that of "two layers of cuticle, plus the remaining tissues included," may be brought below 1,000 ohms, sometimes with continuous current, and frequently with alternating current. As readily stated, Dr. Hedley has found the resistance of the whole body, including the skin, may be reduced to 540 ohms; while in a recent electrocution (MacElvain), the body resistance to alternating currents proved to be as low as 516 ohms from hand to hand, and 214 ohms from head to calf.‡

The conditions under which Dr. Hedley arrives at 540 ohms as the resistance of the whole body, justifies us in regarding that as the minimum under most favourable circumstances—*i.e.*, in a bath when low E.M.F. is used; but we are still left in the dark as to how much, if any, of the resistance so obtained belonged to the skin only.

I have sought to get over this difficulty in a different manner. By inserting two internal electrodes of fairly large area, one in the mouth and the other in the lower part of the body, after passing the current for one minute, I found the resistance to be 534 ohms. Then while the lower electrode remained *in situ*, one of the non-polarisable electrodes described below was substituted for the mouth electrode, and placed upon the cheek outside the mouth. After again passing a current for one minute, the resistance was 1,468 ohms. The difference between these two resistances—viz., 934 ohms—may, I think, be fairly taken to represent the resistance of the skin under one electrode, and, this doubled, gives 1,868 ohms as the resistance of two layers of skin as in ordinary contacts. This conclusion, however, is only good for skin on the cheek or similar skin, with a circular contact of 2in. diameter to each electrode. Skin in other parts of the body may have a greater number of sweat or other glands in such contact area, or it may have fewer, and this, as shown by Erb*, causes proportional variations in resistance independent of other conditions.

The observations recorded below were all taken upon one subject. Two other subjects were tested, and the readings so obtained, while differing somewhat in value, bore out in the main the proportions shown by the first.

Special non-polarisable electrodes were used. They consisted of glass cups, having each a side orifice, 2in. in diameter, covered with a piece of thin bladder. Each cup was filled with a strong solution of zinc sulphate, into which a zinc rod dipped, the other end of the rod passed through a rubber stopper in the neck of cup, and formed

[1] Paper read before the British Association at Edinburgh.

* Leeds meeting, 1890, "Alternating *versus* Continuous Current in Relation to the Human Body," by H. Newman Lawrence and Dr. A. Harries.

† "Electro-Therapeutics," by Wilhelm Erb, M.D.

‡ *Health*, October 5th, 1883.

§ Lumlian Lectures before Royal College of Physicians, April, 1886.

‖ "Hydro-electric Methods in Medicine," by W. S. Hedley, M.D.

¶ *Journal of Society of Arts*, March 13th, 1891.

* "Electro-Therapeutics," by Wilhelm Erb, M.D.

† "Human Physiology," by Augustus Waller, M.D.

‡ New York *Medical Journal*, May 7, 1892.

the terminal to which the battery wire was connected. These electrodes were warmed up to 95deg. F., by immersing the glass body of the cup in warm water till ready for use. When warm, the resistance of the two was 14·5 ohms. When in use the bladder-covered orifice was placed upon the skin. An excellent contact, having only a thin membrane between the skin and a strong saline solution was thus obtained, and it was hoped that complications arising from dry skin, imperfect contact, difference of temperature and surface polarisation, were thereby eliminated.

An ordinary Leclanché battery of 14 cells, giving an E.M.F. of 15 volts, a switch, a current reverser, and one of Edelmen's suspension milliampere-meters, completed the apparatus used.

TABLE B.—Direction transverse—other conditions as in Table A.

—	Time 0	1 min	2 min.	3 min.	4 min.	5 min.
Arm—						
Through hand (back and front)	0·85	0·75	0·68	0·68	0·69	0·7
" forearm "	2·0	4·5	5·7	5·8	5·4	5·0
" upper arm "	2·0	5·0	5·5	5·6	5·7	5·8
Leg—						
Through foot (sole and instep)	0·25	0·4	0·35	0·32	0·31	0·31
" calf (back and front)	0·25	0·9	1·9	2·6	3·0	3·5
" thigh "	0·5	1·5	2·1	2·5	3·0	3·2
Trunk—						
Through chest (back and front)	1·02	2·4	2·8	3·2	3·3	3·5
" abdomen "	0·2	0·7	1·4	2·0	2·5	2·7
" chest (side to side) ...	0·15	[illegible]	0·9	1·15	1·4	1·6

DIAGRAM I.

Longitudinal Currents.—Arm ——— Leg ...... Trunk — —

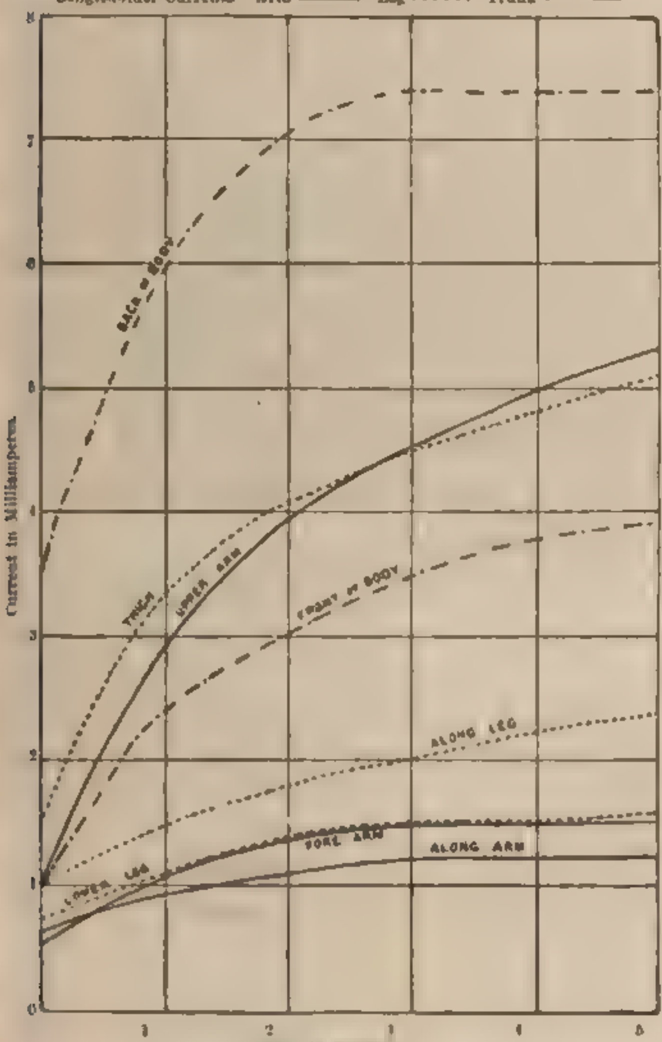


DIAGRAM II.

Longitudinal Currents.—Arm ——— Leg ...... Trunk —·—·—.

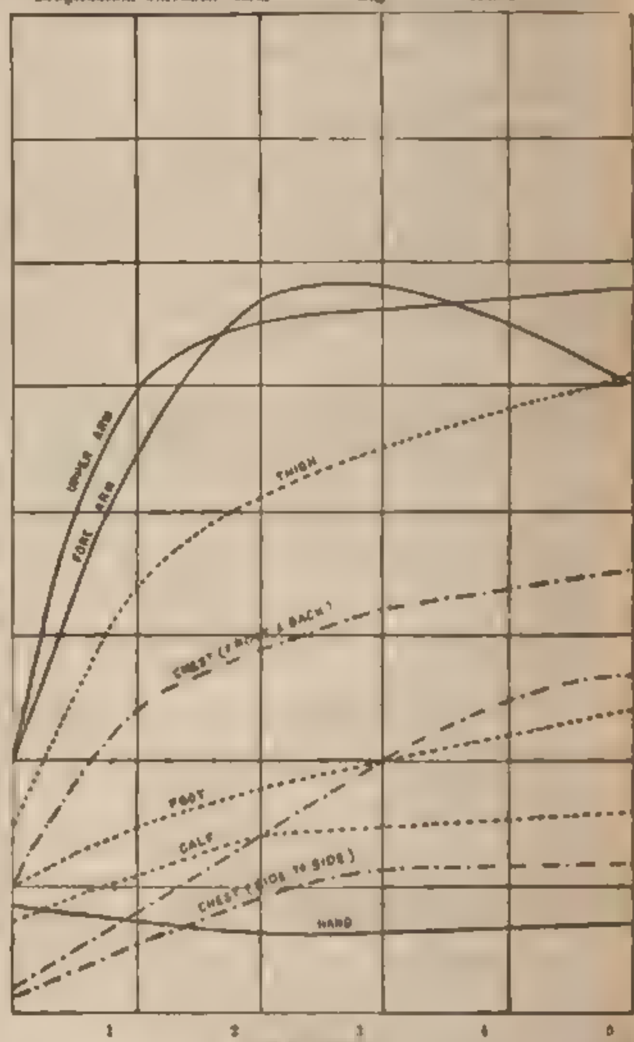


TABLE A.—Conductivity readings. Continuous currents. E.M.F. 15 volts. Direction longitudinal.

Position of electrodes.	Current in milliamperes at					
	Time 0	1 min.	2 min.	3 min.	4 min.	5 min.
Arm—						
Hand (palm) and shoulder.	0·63	0·96	1·08	1·21	1·22	1·22
" and elbow (inside)	0·55	1·1	1·4	1·5	1·5	1·5
Elbow and shoulder	1·0	3·0	4·0	4·5	5·0	5·3
Leg—						
Foot (sole) and hip	1·0	1·5	1·8	2·0	2·2	2·4
" " knee (inside)	0·75	1·1	1·4	1·5	1·5	1·6
Knee (inside and hip)	1·5	3·4	4·1	4·5	4·8	5·1
Trunk—						
Neck and perinæum	3·5	6·0	7·1	7·4	7·1	7·4
Breast and "	1·0	2·5	2·9	3·5	3·8	3·9
" " right hand (palm)	1·0	0·8	0·76	0·75	0·77	0·77
" " left hand	0·6	0·53	0·54	0·56	0·56	0·53
Right hand and left hand	0·2	0·25	0·25	0·25	0·25	0·25
" foot (sole) and abdomen	0·3	0·6	0·6	0·55	0·5	0·5
Left " " "	0·9	0·75	0·68	0·6	0·56	0·55
[illegible]t foot and left foot.........	0·3	0·33	[illegible]	0·34	0·34	0·32

The first thing one notices in these tables is the difference in conducting power of the several parts of the body, and in order to make this point more clear I give in Table C a list of comparisons based upon the figures found at the end of each five-minute period.

TABLE C.—Comparative conductivity, after passage of current for five minutes at an E.M.F. of 15 volts, taking the conductivity from hand to hand as 1.

Longitudinal currents.	Conductivity.	Transverse currents.	Conductivity.
Hand to hand	1·0	Through foot	1·2
Foot to foot	1·3	" hand	2·3
Right foot to abdomen	2·0	" chest (side to side)	6·4
Left hand to breast	2·1	" abdomen (back and front)	10·8
Left foot to abdomen	2·2	" thigh	13·0
Right hand to breast	3·0	" lower leg	14·0
Arm (whole)	4·9	" chest (back and front)	14·0
Forearm	6·0	" forearm	20·0
Lower leg	6·4	" upper arm	23·2
Leg (whole)	9·6		
Front of body	15·6		
Upper arm	20·0		
Thigh	20·3		
Back of body..	29·6		

These figures indicate that there is less conductivity in all parts of the body to transverse currents than to longitudinal ones, even though the distance between the electrodes is very small in the transverse tests. The conductivity of the trunk lengthways is 29·6, while crossways from side to side it is only 6·4 and back to front (about half the length) its highest value is 14.

A curious feature brought out by these records is, that in no case does the conductivity of a whole limb lengthwise correspond with the sum of that of the two sections of which that length is composed. It is considerably less even when we take into account the additional contacts necessary for the sectional readings. I had hoped to find in the readings some indication of the skin resistance at these points, expecting that the difference between the resistance of the limb as a whole, and when taken in sections would represent the value of the resistance of the additional contacts. For example, the whole arm gives 11,758 ohms, and the sectional readings are 9,758 and 2,588, making a total of 12,346. The difference is, however, only 588 ohms, and in the light of other readings is far too small to fairly represent the additional contacts. We have, then, to conclude that the greater part of the limb resistance lies in the hand contact or the foot contact, as the case may be, and there is indication that this is due not so much to the condition of the skin at these points as to the nearness of bony structure to the surface. This view is somewhat confirmed by the great resistance shown by both the hand and foot when the current was passed through them transversely.

I next tried the effect of reversals as shown by Tables D and E.

TABLE D.—Effects of reversals. Longitudinal currents. The reversals made by hand with an ordinary reversing key at the end of each five minutes passage of current, as in Table A and B.

Position of electrodes.	No. of reversals.	Effect on conductivity.
Arm—Hand and shoulder	4	no change.
Hand and elbow	4	C reduced by 0·2 ma.
Elbow and shoulder	4	no change.
Leg—Foot and hip	4	C increased by 0·1 ma.
Foot and knee	4	C reduced by 0·1 ma.
Knee and hip	2	no change.

TABLE E.—Effect of reversals. Transverse currents. Conditions as in Table D.

Arm—Through hand	4	C reduced 0·1 ma.
,, forearm ...	4	C increased 0·3 ma.
Leg—Through foot	4	No change.
,, calf	4	No change.
,, thigh	4	C increased 0·2 ma.

The small effect of reversals here shown is probably mainly due to the fact that owing to the special electrodes used and the temperature of the strong saline solution within them, the skin at points of contact had become a fair conductor. It has already been shown that when the skin is thoroughly moistened, the difference between the resistance to continuous current and that to alternating current is very much less than when it (the skin) is dry.*† It seems, therefore, fair to conclude that the precautions taken had the effect of reducing the surface polarisation to a minimum.

For the more convenient study of the observations here recorded, I have plotted some curves. Those shown in Diagram I. illustrating what happened when the current passed longitudinally, and those in Diagram II. what happened when it passed transversely.

These results of experiment are put forward as indicative rather than conclusive, because though they are true as far as they go, and under the conditions named, yet individual conductivity varies considerably, and other conditions of test may give other results. It is more than probable that the conductivity of the body is greater as a whole when subjected to the comparatively high E.M.F. of light and power circuits, but it is hardly likely that the distribution is altered. Many more subjects must be tested in a variety of ways before definite laws can be established, but it is to be hoped that the day is not far distant when this shall be accomplished, and I for one will continue my efforts in that direction.

It is necessary to emphasise the fact, especially in the light of resistances to alternating currents found in the electrocuted criminals in America, that the effects of alternating currents on the body are not touched upon in this present paper.

* *Journal* of Institute of Electrical Engineers, No. 86, vol. xix.
† Paper by Mr. Swinburne, British Association, Leeds, 1890.

WHITEHAVEN.

In order to test the feeling of the inhabitants with regard to the taking of the electric light, the following circular has been issued:

"Whitehaven Town and Harbour Trust,
"Town Hall, Whitehaven, August 20th, 1892.

"As you are no doubt aware the Trustees are about to erect plant for the generation of electricity for lighting the public lamps of the town, and also for the use of private consumers. It is proposed in the first instance, for purposes of private supply, to lay electric mains in a limited area only, viz., King street, Tangier street, Lowther street and Corkickle; but provision will be made whereby the area of supply can be easily enlarged as demand arises. Before doing so the Trustees are anxious to carefully ascertain what demand for the supply of electricity can be depended upon in the above area, and as your premises are within it, will you please inform the trustees, on the enclosed form, whether you propose making use of the light upon your premises, if so, and to what extent. The cost of the supply will, of course, vary with the demand, the greater the demand the less will be the price at which the trustees will be able to supply the light. The prices proposed to be charged at first are: For each Board of Trade unit of electricity per hour in the maximum power demanded by any consumer a charge of 30s. a quarter; and in addition for each such unit supplied a charge of 2d. per unit. A Board of Trade unit of electricity is equivalent in light to about 32 ordinary gas burners consuming four cubic feet of gas per hour each. The cost of lighting under the above charges will greatly depend upon the number of hours during which the light is used by consumers, and in comparison with the cost of lighting by means of gas (light for light) as follows:

"When the light is used for an average of

1 hour per night it is equivalent to gas at				4s. 0d.	per 1,000ft.
1½	,,	,,	,,	3s. 1½d.	,,
2	,,	,,	,,	2s. 8d.	,,
3	,,	,,	,,	2s. 2½d.	,,
4	,,	,,	,,	2s. 0d.	,,
5	,,	,,	,,	1s. 10½d.	,,
6	,,	,,	,,	1s. 9½d.	,,

"In addition to the cost of the light will be the meter rent at 10 per cent. on the cost of the meter, as with gas meters. Besides the moderate price, as compared with that paid for gas, are to be considered the undoubted advantages of cleanliness, brilliancy, and clearness of the light, absence of heating, and purity of the atmosphere of the rooms where used, and a perfect freedom from danger of explosions. The consumer will, of course, provide his own internal fittings and lamps, either by purchase or hire; and as regards these he is advised to make his own inquiries, the cost of same varying very much in the character of the fittings, the position and number of lights, and the internal arrangement of the premises to be lighted but may be taken to cost the purchaser on average from 15s. to 20s. per light installed. It is particularly requested that replies on the accompanying form be filled in as early as possible, as the forms will be collected on or about Saturday, the 27th inst.—Yours obediently,

"JOHN COLLINS, secretary."

NEW COMPANIES REGISTERED.

Kennedy Storage Battery Company, Limited.—Registered by C. H. Hodges, 12, New court, Carey street, W.C., with a capital of £100,000 in £1 shares. Object: to adopt and carry into effect an agreement, expressed to be made between Patrick Kennedy and C. J. Diss of the one part and this Company of the other part, for the acquisition of certain letters patent relating to improvements in secondary or storage batteries, and to carry on in all its branches the business of electricians, electrical engineers, electrical contractors, mechanical engineers, suppliers of electricity, and manufacturers of electrical appliances of every description. The first subscribers are:

	Shares.
W. J. Sutherland, Seaford, Sussex..................	1
J. Dunham Massey, 53, Old Broad street, E.C..........	1
G. C. A. Kohler, 17, Fenchurch street, E.C............	1
H. J. Alfred, 20, Moorgate street, E.C................	1
G. M. Gordon, 34, Colby-road, S.E....................	1
W. Simpson, Wivenhoe, Wood green....................	1
L. L. Simpson, 26, Dover street, W...................	1

There shall not be less than five nor more than 10 Directors, the first to be elected by the signatories to the memorandum of association. Qualification, 500 shares. Remuneration to be fixed by the Company in general meeting.

BUSINESS NOTES.

Western and Brazilian Telegraph Company. —The receipts for the past week after deducting 17 per cent. payable to the London Platino Brazilian Company, were £3,283.

West Hartlepool. —Messrs. R. H. Barnett and Co., electrical engineers, of Volt Works, Walker Gate, Newcastle-on-Tyne, have obtained the electric light contract for the West Hartlepool Co-operative Society's new premises.

Hammond and Co. —Besides the Dublin station just finished, this firm has in hand central stations for Leeds and Blackpool, while preliminary preparations are going on for erecting the electric light works for the Burton-on-Trent Corporation.

City and South London Railway Company. —The receipts for the week ending August 28 were £805, against £717 for the same period of last year, or an increase of £88. The total receipts for 1892 show an increase of £558 over those for the corresponding period of 1891.

New Telegraph Station. —A new station for the reception and delivery of transatlantic telegrams will be opened by the Direct United States Cable Company, Limited, to-day, at 39, Mark-lane, E.C., which will be in direct communication with the Company's transatlantic cable system.

Mansion Lighting. —Messrs. Ernest Scott and Mountain are busy with installations for private houses, having in hand a large installation for Lord Ellesmere at his house and training stables at Newmarket, and are also lighting Benmore House, the residence of H. J. Younger, Esq., Argyleshire. Amongst local contracts may also be mentioned the lighting of Manor House, Newcastle-on-Tyne, the residence of James Knott, Esq.

Coventry. —Owing to the rapid increase in the business of the Coventry Electrical Engineering Company, they have been compelled to remove into larger and more central premises, situated in Ryley-street, Coventry. They have also taken into partnership Mr. W. J. Butlin, who has had a large experience of American electrical work. The "Coventry" dynamo is a solidly-built machine, and is largely in use in Coventry, Birmingham and the neighbourhood. A speciality is made of dynamos for refining, giving 30 up to 3,000 amperes, and dynamos are built to any specification.

Vulcanite. —This material has become one of the most useful and important to electrical engineers, and a rather novel method of emphasising this fact has been taken by the Harburg India-rubber Company, in the shape of the issue of a vulcanite prize medal, one of which the London agent, Mr. F. Winter, of 138, London-wall, has sent us. One of these vulcanite prize medals, which is artistically executed, has been sent out to each of the firms or persons who have received a medal in the recent Crystal Palace Exhibition. They constitute rather a unique advertisement of a firm, a large number of whose hands (in all about 800 engaged in the manufacture of this one material) are regularly employed in the production of vulcanite articles for electrical engineers, counting amongst their regular clients the leading firms in all the different branches of electrical industry—telegraphs, telephones, electric light engineers, accumulator manufacturers, and so forth, as well as the British, German, and other governments. The medal is an interesting souvenir of the exhibition, and an example of the enterprise of the Harburg Company.

PROVISIONAL PATENTS, 1892.

AUGUST 22.

15113. **Manufacture of caustic, soda and potash, and hydro-chloric acid by electrolytic treatment of chloride of sodium and chloride of potassium, and apparatus for this purpose.** Jean Paul Roubertie, Victor Lapeyre, and Ulysse Grenier, 28, Southampton-buildings, Chancery-lane, London.

15120. **Improvements in or applicable to electrical accumulators or secondary or storage batteries.** Henry William Headland, 226, High Holborn, London.

AUGUST 23.

15167. **Electrically illuminated signs or devices, partly applicable to other purposes.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Almon Dobbins Page and Edwin Joseph McAllister, United States.) (Complete specification.)

15170. **Improvements in or connected with electromagnetic alarm apparatus.** Berthold Hoffmann, 23, Southampton-buildings, Chancery-lane, London.

15179. **Improvements in arm rests for telephone operators.** Joseph R. Bailey, Levi C. Lincoln, and the Woodsocket Edge Tool Company, 77, Chancery-lane, London. (Complete specification.)

15188. **Improvements in electric arc lamps.** Eduard Friedrich Hermann Heinrich Lauckert, 28, Southampton-buildings, Chancery-lane, London.

15194. **A new or improved telephone transmitter.** Erhard Ludwig Mayer and Alexander Chalmers Jameson, Norfolk House, Norfolk-street, Strand, London.

15197. **Improvements in electrolytic apparatus.** Hippolyte Marie Emil Andreoli, 61, Chancery-lane, London.

AUGUST 24.

15225. **A new electric contact lamp.** Carl Anton Johannes Hugo Schroeder and Heinrich Eugen Richard Schroeder, Whetstone House, Heslop-road, Balham, London. (Complete specification.)

15238. **Improvements relating to telephonic switching apparatus.** Alfred Rosling Bennett, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

15240. **Improvements in jointing or junction boxes for electric cables or wires.** Hayward Tyler and Co., and Charles Pollard Hammond, 77, Chancery-lane, London.

AUGUST 25.

15296. **Improvements in and appertaining to electrical accumulators.** Henry Clay Bull and John Ramage, 15, Water-street, Liverpool.

15298. **Improvements in holders for incandescent electric lamps.** Frank Bryan, 11, Brackley-terrace, Chiswick, London.

15315. **Improvements in electrical batteries and their application for curative and remedial purposes.** Reginald Wilmot Hayes, Newington and Edward Priddle, 1, Queen Victoria-street, London.

15318. **Improvements in electrical transformers.** Henry Harrington Leigh, 22, Southampton-buildings, Chancery-lane, London. (Giulio Maria Apollony, Italy.) (Complete specification.)

15319. **Improvements in and relating to electric batteries.** David Fishman, 45, Southampton-buildings, Chancery-lane, London.

AUGUST 26.

15329. **Improvements in gas, electric light, and lamp fittings.** Edward Horton, 6, Livery-street, Birmingham.

15356. **An improved electro-chemical process for treating iron pyrites, thereby recovering everything valuable contained therein and avoiding all noxious fumes.** Henry Clay Bull, 15, Water-street, Liverpool.

15372. **Improvements in the method and means of obtaining electricity.** William Boggett, 34, Southampton-buildings, Chancery-lane, London.

15377. **Improvements in switches for electric lighting.** Robert Lund Hattersley, 45, Southampton-buildings, Chancery-lane, London.

AUGUST 27.

15405. **Improvements in and connected with telephone switches.** Hermann Oppenheimer, 34, Aldermanbury, London.

15426. **Manufacture of an elastic compound for electrical insulation and other purposes.** John Welch Savage, 28, Southampton-buildings, Chancery-lane, London.

15437. **An improved method of making electrical contacts between parts of electrical apparatus.** William Ernest Gray and William Arthur Price, 6, Bream's-buildings, Chancery-lane, London.

15441. **Improvements in electric arc lamps.** Arthur James Howes, 28, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1891.

13492. **Electrical propulsion of vehicles.** Elmore.

14834. **Electrically-propelled vehicles.** Heys. (Brown.)

15834. **Carriers for electric lamp shades.** Drake and Gorham.

18887. **Electric railways.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

18890. **Rotary-phase current motors, etc.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

1892.

12306. **Secondary batteries.** Lee.

12417. **Electric brazing and soldering.** Mitchell.

12436. **Electric insulators.** Lake. (McCarthy.)

12442. **Electrically lighting and heating railway, etc., vehicles.** Aldet and others.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	Price Wednesday
Brush Co.		[illegible]
— Pref.	–	[illegible]
City of London	–	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
House-to-House	5	[illegible]
Metropolitan Electric Supply	–	[illegible]
London Electric Supply	5	[illegible]
Swan United	$3\frac{3}{4}$	[illegible]
St. James	–	[illegible]
National Telephone	[illegible]	[illegible]
Electric Construction	10	[illegible]
Westminster Electric	–	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]

NOTES.

Maidstone. — The Electric Light Committee has adjourned for a month.

Telephony in Japan.—The number of subscribers in Tokio is said to be over a thousand.

Buckhaven.—The electric light was used last week for the first time at Mulredge Colliery.

Electric Harmonium.—An electric harmonium has recently been constructed in Italy by M. G. Tamburini.

The New Telephone —We understand that tubes have been laid sufficient for the requirements of 15,000 subscribers.

A New Microphone.—It is stated that M. F. Heller, of Nurnberg, has constructed a new microphone, the contacts of which float in quicksilver and touch the membrane.

Electric Welding.—According to Kirkcaldy's tests of welds by Benardos, the mean of the electrically-heated welds is over 18 per cent. better in figure of merit than the mean of the hand-made welds.

Change of Name. — Mr. Reginald John Jones, M.I.E.E. and A.M.I.C.E., has, by a deed poll duly enrolled, renounced the surname of Jones, and will in future always assume and use the surname of Wallis-Jones.

Revoked.—At the last meeting of the Bishops Stortford Local Board, formal notice was received from the Board of Trade that the powers given to the Bishops Stortford Electric Light and Steam Laundry Company had been revoked.

Personal. — Mr. Herbert Laws Webb has returned from his long sojourn in the States for a short holiday in England. Mr. Webb is at the present time contributing some submarine cable reminiscences to our American contemporary *Electricity*.

A New Train Signal.—At a recent meeting of the Société Internationale des Electriciens, M. H. Pellat gave a description of an apparatus intended to indicate the speed of trains, and of a system of signalling proposed to prevent collisions on railways.

Marseilles.—The electric tramway recently established here is running with great success. The line is about six kilometres in length, and the rails are double for a large part of the way. The station contains three dynamos to provide the current for the motors.

Valence.—The central station will soon be completed, in which Heilmann's dynamos are driven by gas engines. The machinery has been constructed by Messrs. Weyer and Richemond, who are interested both in the construction of gas engines and of the Heilmann dynamos.

A Chance for the Gas Journals.—On Saturday evening, August 27, the electric light in a number of the shops in the High-street, Chelmsford, went out for some time. This was caused by the rain-water getting into the pits in which the wires are placed. Of course, nothing ever happens to gas.

Accrington. — The Accrington Town Council on Monday resolved to purchase the gas and water works for £713,220, being 33 years' purchase, subject to the experts' reports being satisfactory, and to the ratepayers' approval. Several councillors urged that the price was too much in view of the progress of electric lighting.

Tenders Wanted.—The Stadtmagistrat of Fiume, Austria, invites tenders for the construction and working of a tramway for both passenger and goods traffic in that town. Electricity may be used as the motive power. Copies of the specification and conditions can be obtained on application to the Stadtbauamt (municipal town building office), Fiume. Offers will be received up to the 1st October, when the tenders will be opened.

Southport.—A somewhat out-of-the-way fine has been imposed upon the Southport Corporation by the local magistrates. It seems that an uncertificated electric launch has been plying between the marine lake and the sea front, and for allowing this the Corporation—as we say—has been fined 20s. and costs. For the defence it was argued that the electric launch was not a ship, and that the Merchant Shipping Act did not apply to craft used on an artificial lake only 4ft. deep. Notice of appeal has been given.

Altrincham District.—A conference of local authorities, including the Altrincham and Bowdon Local Boards, the Altrincham Rural Sanitary Authority, and the Knutsford Highway Board, was held at Altrincham on Tuesday evening to consider a proposition for supplying the electric light to houses, public buildings, and streets in their districts. The members expressed themselves generally in favour of the application of the electric lighting company, and appointed a committee to consider details and report to a future meeting.

Peckforton Castle.—An electric light installation is being carried out at Peckforton Castle, the seat of Lord Tollemache. An engine-house has been built near the entrance to the grounds, which contains a 40-h.p. Robey engine, of the locomotive type, which serves the double purpose of working a saw-mill and the dynamo. The latter is of the Scott-Sisling type. It charges 56 E.P.S. accumulators. From the engine-house a cable, 900 yards in length, conveys the current to the castle. The wiring is being carried out on the concentric system.

Watering Streets.—Our American cousins are nothing if not ingenious and progressive. The latest introduction is in the utilisation of the electric tram line for the purpose of watering the streets. A watering-car, built something after the fashion of the ordinary tramcar, with a horizontal pipe for the distribution of water, is run along on the ordinary track. The distributing-pipe is jointed close to the car, and can be very easily lifted against the side of the car to allow of the passage of ordinary vehicles. It is easily seen, however, that in a great many instances a large track could be watered without having to raise the pipe.

A Correction.—In our last issue, on page 229, when writing on incandescent lamps and current, the word written in the sixth line from the bottom of the second column was *fewest*, which by some mischance got printed *final*. Anyone, however, would see that the latter was an error, it being the lamps which usually require the fewest watts that soon deteriorate, or, in other words, that soon increase their required consumption. We have made enquiries in other directions upon the subject of the note, and we find that the recommendations of Messrs. Siemens and Halske are considered generally to be very good.

Fire on a Mail Steamer.—According to Reuter, the Japanese papers received at Victoria, B.C., discuss the fire which recently broke out on board the mail steamer "Empress of Japan," while in the Pacific, and necessitated the vessel's return to Hakodadi. They condemn the fitting up of electric wires in the inaccessible afterhold, which in time of peace is filled with cargo, and in time of war would contain gunpowder. In the latter case nothing, they declare, could save the steamer from being blown up. It will be seen that this discussion does not attribute the fire to the electric wires, but it points out what may be a grave

defect. We quite agree with the view that the wires should not be inacessible.

Electricity in Mining.—Mr. Irving Hale discusses in the September number of the *Engineering Magazine* of New York the question of electric power in mining. This is done in an article which deserves very careful consideration, because although in this country itself, with certain exceptions, water power is not largely available, in many of our colonies—that is, in the places where our productions should be able on many grounds to compete satisfactorily with the productions of any other country—water power is largely available, and under conditions where it might be utilised for the production of an electric current. The industry in England, then, should see that the agents abroad are kept fully alive to the importance of not neglecting this development.

Falmouth.—During a lecture on the "Applications of Electricity," by Mr. R. N. Worth, F.G.S., at which Canon Rogers presided, the lecturer said, unfortunately in the West the large towns were lacking in public spirit, and St. Austell and Okehampton by installations for electric light and power had put them to shame. In Devon and Cornwall the tidal power and the power of the rivers and streams could easily be utilised to supply electricity. In Germany the power developed on the Rhine 100 miles away was by means of a dynamo and copper wire conveyed to Frankfort. In the future he believed electricity would be applied for many domestic purposes, such as driving sewing machines, cooking food, and heating irons, and that plumbers would use it for soldering, and miners in their lamps.

Transmission of Power in Switzerland.—The Vevey engineering works are completing plant for the electrical transmission of 300 h.p. by continuous currents for the Monthey sugar factory. The motive power will be obtained from the Viège, a tributary of the Rhône. The fall of water available is about 108ft., and either one or two cubic metres of water will be used per second, two metres giving 600 h.p. The installation will comprise a generator of the Koechlin type, of 300 h.p., coupled direct to the vertical shaft of a turbine running at 240 revolutions. The E.M.F. will be 1,000 volts, and the distance from the generating station to the sugar factory just exceeds one mile. Two motors of 125 h.p. each will be operated at the factory, and the installation is to be in operation on the 15th inst., when the sugar campaign commences.

Utilising Water.—While the question of utilising the various weirs on the Thames for generating electricity for town purposes is under discussion in more places than one, it is interesting and encouraging to hear that Lord Boston, of Hedsor Castle, near Cookham, on whose estate there is a weir, intends turning it to account for the purpose of electrically lighting his mansion and grounds. This, says the *Windsor Guardian*, is praiseworthy enterprise, but it is not quite so surprising when it is realised that Lord Boston has hitherto had his own private gasometer on the estate for lighting and other purposes, although there are large gas works near by at Taplow. A similar circumstance is that Sir Roger Palmer, of Taplow, has arranged for the supply of electric light through wires stretched over the river from the works of Mr. Bowen, at Ray Mead.

Leeds Electric Lighting.—The construction of the Yorkshire House-to-House Electricity Company's works and plant for supplying the electric light in Leeds is proceeding apace, and we understand that in the course of a few days the work of laying the mains in the streets to be first lighted will be commenced and vigorously pushed on. These streets include practically all the centre of the town, and also the route to Headingley. The company, in their circular to intending consumers dated June last, expressed the opinion that their works would be in operation in November, and the progress already made renders it practically certain that this expectation will be fulfilled. The local firms who undertake the business of supplying and installing the necessary fittings for electric lighting are receiving numerous enquiries and orders, and with the near approach of the time named by the company for commencing to supply light, a considerable rush of business is confidently anticipated.

Bowness. — An extraordinary meeting of the Local Board was held the other day in consequence of an application which had been made to the Westmoreland County Council by an electric lighting company regarding the introduction of the electric light, and the company had applied to the Board for sanction to lay cables throughout the Board's district, and there being a meeting of the County Council it was thought advisable that the question should be discussed without delay. Similar questions to this will probably come before many of the local boards and the county councils. In this case the committee of the County Council have been requested to withhold their decision until it be seen what conditions the company were likely to comply with, and what concessions they were willing to give. Of course, the county council, in conjunction with the local boards, are answerable for the due maintenance of the roads and streets.

Book Received.—We have received from Messrs. E. and F. N. Spon a copy of "The Phonograph and How to Construct It: With a Chapter on Sound"; by W. Gillett. The larger portion of this work, says the author, was originally published in the pages of the *English Mechanic*, but it has been very largely re-written, and is undoubtedly the most complete monograph upon the subject. Our ideas upon the subject of the phonograph are fairly well known. We have never admitted that it could come generally into use for business purposes, but that it is extremely useful for certain scientific investigations, and it may be to assist in constructing talking-dolls and such-like pieces of apparatus. We have no doubt but that it may command a large sale. The book enters fully into the description of how to make it, and we have no doubt that if no patents intervene anyone following the description herein given could produce a very good phonograph.

Lighting of Mines.—A correspondent writes to the *Times* to the following effect: "Electric lighting seems to be the only safe method by which fiery mines can be worked, and in 1886 the report of the Royal Commission on Accidents in Mines dealt very fully with the question, and stated that 'It may confidently be expected that efficient lamps, worked by primary batteries, will ere long be available for use in mines at a prime cost not very much greater than that of some of the best forms of safety lamps and that their maintenance in working order will also not entail much greater outlay and trouble.' Since 1886 there have been several portable electric lamps invented, from which colliery proprietors could make selection, and, although the first expense would exceed that of miner's oil lamps, the weekly cost of maintenance would be about the same as at present, with the advantages of absolute safety and so superior a light that output could be doubled. If mineowners are wilfully blind to the safety of their men, Government should insist upon proper means being taken and compel a better system."

Blackpool Electric Tramways.—At a meeting of the Blackpool Town Council, Councillor Heap, on rising to move the confirmation of the minutes of the Finance

Committee, said that some time ago the Corporation decided to take over the plant, etc., of the electric tramway company, the chief reason being that the agreement of the company with the Corporation had not been fulfilled, and especially that they had not provided sufficient accommodation for the public in the shape of waiting-rooms. The Corporation had advertised for tenders for the taking over of the tramways, but none came in, and so they had to take them over themselves. They were placed in a very awkward position. Through the hanging up of their Bill in Parliament, as a result of the dissolution, they had no power to pay the company out. However, these difficulties had been largely overcome and a very satisfactory end come to with the company. They asked for £15,750, this sum to discharge all liabilities. He thought it was very satisfactory that an understanding had been come to without having recourse to arbitration. Towards this sum they had borrowing power for £6,500, and they had decided to borrow £9,500 to complete the purchase. The minutes were confirmed.

Business Methods.—No doubt many of our readers have heard of the method by which some enterprising City men manage to rake in the current coin of the realm when they promote a company, no matter whether the company is good, bad, or indifferent. It is by sending thousands of circular letters broadcast through the country, such circulars being highly laudatory of what is being put on the market. No doubt this is business, and those who become shareholders deserve no sympathy. Something like this goes on in electric lighting. We find syndicates and companies, more or less known or unknown, writing letters to all local authorities, and ofttimes these letters contain statements which are somewhat different to what practice will confirm. We have no objection to urge against this method of obtaining business providing the statements made are correct. At other times the local authority takes the initiative, as does frequently a private individual, and writes to various firms and companies asking for a volume of information about this, that, and the other, with no real intention of, at that time, transacting any business. It is exceedingly difficult for business men to know whether an application for business is *bonâ fide*, and when it is not so the result frequently causes a vast amount of trouble and expense, while there is nothing to be gained thereby.

The Brush Company's Works.—The current number of the *Manufacturers' Engineering and Export Journal* deals this month very exhaustively with the Brush Company's works, both in London and in Loughborough. The article is, we were going to say, exhaustively illustrated—containing, as it does, portraits of the directors and managers, as well as illustrations of the company's works and the apparatus made. We take from the article the following list of the principal central electricity supply stations equipped by the Brush Company: Mordey-Victoria alternate-current transformer system: Avila (Spain, in progress), Bangkok, Bath, Bejar (Spain), Bilbao, Bournemouth, Cape Town (harbour offices, wharves, etc.), Carces (France), Durango (Spain), Embrun (France), Exeter, Hastings, Huddersfield (in progress), Kapurthala (India), La Plata, Lequeitio (Spain), City of London (Central and Western Divisions), Lynton, city of Mexico, Minas (Brazil), Newcastle-upon-Tyne, Segovia (Spain), Shanghai, Sheffield, San Carlos do Pinhal (Brazil), Temesvar (Hungary, streets lighted exclusively by electricity), Worcester (in progress). Direct-current system, with accumulators: Chelsea and Manchester. Direct-current low-tension system, without accumulators: Greenock, Naples, Novara (Italy). Brush series system: Brighton, Eastbourne, Hastings, Hyères (France), Kimberley, Launceston (Tasmania), City of London (temporary installation, 1881-1886), Marseilles, Riverstone (Queensland), St. Saviour's District, Southwark (temporary lighting, 1881-1886).

Melbourne.—In Australia, as in this country, it will be found that some of the earliest clients of electricity, and, in fact, electrical apparatus, are to be found in the banks and large insurance offices: thus the new offices in Collins-street for the Native Mutual Insurance Association are to have one of the most complete electrical installations in Australia. Messrs. Pascoe and Gosche, to whom the contract for the entire electrical installation has been let by Mr. R. Gamlin, are now proceeding with the wiring of the building for the electric light, enquiry indicators, and a complete telephonette service, etc. A special feature in this installation is the fact that nearly all of the fittings are to be manufactured in Melbourne. The telephonettes, which are a colonial invention, and manufactured by Messrs. Pascoe and Gosché, are distributed all over the offices of the building, connecting the latter with a number of similar instruments in the entrance hall, placed there for the convenience of the public. The whole electrical arrangement in the entrance hall is mounted on an artistic framework in Gothic style, and designed by Mr. Beaver, the architect of the building. The work is being carried out under the supervision of Mr. W. A. Gosché. The development of electric lighting in the Australian Colonies must be partly placed to the credit of the agents of the English companies who reside there, who are very energetic, and are well supported in many instances by the people at home. Take, for example, the Brush Company, which for the purpose of giving information has just issued a booklet containing matter compiled, to a great extent, from lectures by Mr. W. H. Preece, F.R.S., and Mr. R. Percy Sellon, M.I.E.E., which is very interesting reading.

Therapeutical Effects of Alternating Currents. Experiments have been undertaken by Dr. J. Larat and M. J. Gauthier to ascertain what the influence of electric treatment by means of alternating currents might have upon nutrition in cases of illness. The same as d'Arsonval utilised in his experiments a method based on the measure of the respiratory capacity to determine the influence of electric currents from a physiological point of view, so MM. Larat and Gauthier estimate the results of electro-therapeutic treatment by a chemical analysis capable of revealing, as it were, this direct influence, or at least its resultant. This analysis is the treatment of the urea, a process which reveals the degree of oxidation of the globules of blood, under an approximate value in regard to the influences caused by the varied range of alimentation. The experiments have shown that alternating currents could increase the respiratory capacity by 50 per cent. The electric treatment, says the *Bulletin Internationale de l'Electricité*, consists in the application of baths in the form known as hydro-electric baths, the current, after passing through transformers and special graduators, being brought to the bath by two carbon electrodes. It has been found by experiments extending over a year that the electric treatment has effected a perceptible improvement in cases of gout, chronic rheumatism, diabetes, obesity, etc., and in all persons having "relaxed nutrition." In several cases the relief found from the first few days has been accompanied by a cure, and, among other things, it was noticed that with certain corpulent individuals a single bath was sufficient to reduce the weight by 250 grammes (8¾oz.), notwithstanding the fact that the appetite of these persons increased. M. Larat also found it possible to cure several

persons suffering from eczema, and from this result he and M. Gauthier think that it will probably become possible to modify the temperament of certain scrofulous children.

An Electric Fire Station.—It is with deep concern that we find our contemporary the *Journal of Gas Lighting* for once—so far as we remember for years past—mentioning anything electrical without sneering at everything connected with it, or putting it down as an absurdity. Messrs. Siemens, however, have, it seems, converted the usual irate medium into something savouring an approach to sanity. Many of our readers will recollect the display that Messrs. Siemens gave of their electric fire engine at the Crystal Palace and at Manchester. It seems to be one of those excessively ingenious ideas which, among other applications of electricity, will, when the current is easily obtained, prove of great advantage. This is what our contemporary says about it: "A somewhat remarkable suggestion for the occasional utilisation of electric lighting currents distributed by street mains from central stations is contained in the so-called electric fire engine manufactured by Messrs. Siemens Bros. and Co., Limited. The carriage and frame of the engine are of the pattern adopted by the Metropolitan Fire Brigade, and made by Merryweathers. The usual steam boiler and pumping engine are, however, replaced by a Siemens electric motor, driving an 'Oddie' pump, which, by the way, looks as if it might be used for exhausting gas. The idea is to fix iron pillars, similar to hydrants, at convenient positions in the streets, carrying two branch wires from the electric mains, which terminate in a concentric union, to which a flexible concentric cable can be attached. Successive lengths of this cable can be connected up if the engine is desired to work at some distance from the junction pillar, and the whole connection is made to look and handle as much as possible like an ordinary hose pipe. Of course, any sort of rotary pump could be driven by the electromotor, but the new 'Oddie' pump has been selected probably because it works at a high velocity, and will stand a good deal of back pressure. The electromotor makes about 450 revolutions a minute, and the pump will deliver at a pressure of 75 tons per square inch."

Telephonic.—Some interesting particulars have been furnished by Dr. Behn-Eschenburg, of the Oerlikon Engineering Works, concerning the influence which the working of the Killwangen Zurich rotary-current installation has had upon telephone wires, and the manner in which the disturbances were removed. It appears that the generating station is situated in the neighbourhood of the Zurich-Baden Railway at Killwangen, about 12½ miles from Zurich. The primary dynamo gives current at a terminal pressure of 50 volts, which is transformed up to 300 volts. The sub-stations are located in Zurich and environs, each having one or more converters which reduce the pressure of the current, which is used both for motive power and for lighting purposes. During the working of the plant, which is reckoned at 300 h.p., regular buzzing noises were remarked in all the telephone wires which were in connection with the sub-stations or the primary station. The telephone subscribers complained of interruptions, which they said were worse in damp than in dry weather. This circumstance led to the supposition that the disturbances were caused by leakage between the strong current and the telephone conductors. At the Killwangen generating station the neutral point of the primary and secondary leads of the transformer were connected to earth, as was also the case in those sub-stations which only supplied current for lighting; whilst in the stations from which motors were operated only the neutral point of the low-tension current was grounded. When the earth connection of the transformer in the station for the distribution of light was interrupted, the humming noises in the telephone of this station almost completely ceased, whilst in the other stations the disturbances continued; but when the earth connections in these stations were removed, the noises in the telephone wires also ceased. A similar result was obtained in all the stations when the earth lead at the primary station alone was disconnected from the earth. The supposition is therefore confirmed by these tests that the interruptions in the telephone wires with this installation were brought about by the passage of current from the earth, which formed the central lead of the system.

Conductivity in Mixed Solvents.—According to the abstracts in the *Journal* of the Chemical Society, Arrhenius has dealt with this subject, which is of considerable interest to those who have anything to do with electrolysis. His conclusions are as follow: "When a portion of the water in the aqueous solution of an electrolyte is replaced by a non-electrolyte, such as alcohol, so that the total volume remains unchanged, the electrolytic conductivity of the solution diminishes. If the quantity of non-electrolyte added (x), does not reach more than 10 per cent. the conductivity of the solution may be expressed by the formula $l = l_0 \left(1 - \frac{a}{2} x\right)^2$, where l_0 is the conductivity of the pure aqueous solution, and a an empirical coefficient. The author has investigated 55 different electrolytic solutions with regard to the influence on their conductivity of six non-electrolytes (methyl alcohol, ethyl alcohol, isopropyl alcohol, ether, acetone, and cane sugar), the strengths of the solutions and the quantities of non-electrolyte added being varied. The decrease of the conductivity brought about by the addition of 1 per cent. by volume of the non-electrolyte (a) depends on the nature both of the electrolyte and of the non-electrolyte, varying between 1·5 and 4 per cent. of the conductivity of the pure aqueous solution. As the concentration of the electrolyte increases, a is in general the greater; and the variability of a with the concentration is such that it is smaller, the greater the degree of dissociation of the electrolyte is. The diminution of the conductivity by the addition of a non-electrolyte is partially due to the increase of the fluid friction of the solution, which lowers the speed of the ions. In the case of substances that are strongly dissociated (most salts, and strong acids and bases), the diminution is due almost entirely to this cause, and the relation between it and the increase of fluid friction may be expressed by the formula $1{,}000\,a = C + 1{,}000\,C'\,(A - 1)$, where A is the fluid friction (compared to that of water as unity) of a solution with 1 per cent. of the water replaced by the non-electrolyte, and C and C′ are constants which are the same for various groups of electrolytes. Here the addition of the non-electrolyte does not alter the degree of dissociation. On the other hand, when the dissolved substances are only feebly dissociated, the addition of the non-electrolyte not only diminishes the speed of the ions, but also diminishes their number. This diminution of the degree of dissociation is greatest with non-electrolytes that contain no hydroxyl groups, becoming less as the number of hydroxyl groups in the molecule increases. Temperature has only a slight influence on the proportional diminution of the conductivity, this diminution, however, becoming always smaller as the temperature rises. The author indicates how to correct the observed conductivity of a solution for fluid friction, so as to reduce the value obtained to that in a liquid whose fluid friction is equal to that of pure water, and, finally, points out the method of applying his results to the determination of the ash in sugar solutions (molasses) by means of observations on the electrolytic conductivity."

SHOULD YOUNG ELECTRICAL ENGINEERS GO INTO BUSINESS?

BY SYDNEY F. WALKER.

In the opinion of the writer of this article, the number of young fellows who have trained as electrical engineers who may hope to be successful in business on their own account is very small indeed. Very few believe this, of course. In some cases it is argued that one's parents, having paid so much as premium, and oneself having worked a certain number of years without remuneration, one ought to be worth a good salary, and if selfish firms will not see matters in the same light, one will have a try on one's own account. In other cases, after perhaps holding fairly good positions for a certain time, young fellows get the impression that they are earning all the profits while their employers are taking them, and doling out to them what they consider a miserable pittance.

In other cases, again, a young fellow has some difficulty in getting a billet that he thinks equal to his qualifications, and forthwith elects to set up on his own account. It must be confessed that youngsters are not the only ones who behave in this way. Often men of mature years do the same. The impression prevails among nearly all engineers that the qualifications necessary to run a business successfully are very much inferior to those required to carry out engineering work; that, in fact, no training, no special abilities at all are needed. Yet the truth is that a very much higher order of ability is necessary to run a business successfully, than for almost any other kind of work, whether it be professional or non-professional. Anyone who will take the trouble to enquire into the matter will find that the success of all large concerns, even large engineering concerns, is due to some able man, not usually an engineer, who is perhaps not seen or heard much of, possibly not much thought of, yet who is to the business what the captain is to the ship, the admiral to the fleet, or the general to the army. Without being as intimate with the details of the different branches of the business as those under him, often knowing very little of those details, as his subordinates understand knowledge of them, he is yet able to guide men who are really his masters in their own departments, and to ensure success where otherwise failure would result. It is usually better, though not always, if the master mind in an engineering business has a good knowledge of the branch of engineering his business deals with, but in very many instances ability in engineering is not accompanied by commercial skill. The man who is an engineer before everything is apt not to count the cost of his work. He has a difficulty to get over, and he proceeds to work his way throught it regardless of everything but the one object he has set before himself.

Or, again, the man who is purely an engineer, without the higher commercial gift, is apt to waste money in producing what may be termed unnecessary and expensive excellence. A dynamo is designed with a certain efficiency. When the work is well in hand, the designer discovers that he could, by certain alterations, have got, say, 5 per cent. higher efficiency. He does not stay to consider whether he will get a return for the additional expenditure. Very often the users of the machine will get absolutely nothing for it. In some cases they will even be involved in larger maintenance charges. Yet the one thing the engineer aims at is to produce a machine more perfect than has been produced before. In a small business, where the engineer is himself also the commercial man, such a course would be fatal to success. In a large concern, where the engineer was only the head of a department, he would not be allowed to involve his firm in useless expenditure of this kind. His chief would soon stop that.

Another reason why few engineers, especially young ones, can be successful in business on their own account is, because of the fact, which is usually entirely overlooked, that they must be their own chiefs of departments as well as their own commercial head. The proprietor of a small engineering business should be a skilled accountant, a clever salesman, a good traveller, a good storekeeper, a good collector of accounts, a skilful manager of men, a good buyer, and should possess other qualifications besides; and his skill as an engineer should be of a very high order, as he must constantly be ready to tackle engineering problems which men who are paid very high salaries by large concerns do not consider beneath them. Where a good working partnership could be formed between an accountant and an engineer, many of the above difficulties should disappear. But this is rarely possible. Accountants usually imagine that they understand engineering better, from the glimpses they get of its outer workings than men who have spent their lives in its study, and though they usually develop into good commercial men from their habit of constantly counting the cost, they do not always. On the other hand, engineers are usually suspicious of accountants, so that the result is, each spends a large portion of the time that should be given to the general good of the business, in meddling with and generally muddling the other's work.

Young fellows who have been on the staff of some large concern imagine that all the duties that have been named—bookkeeping, selling, collecting accounts, travelling, etc.—will be done for them by subordinates just as they were in the business they left. But they forget that if these duties are performed for them, the men who perform those duties must be paid, and if the duties are to be as well performed as in the concern they have left, the pay must be somewhere in the same proportion, and that these payments must come out of the profits of their business. As no small business can possibly afford this, it means that the proprietor himself has to undertake the whole of them, getting just as much assistance in each department as he can afford to pay for. Where there are partners, of course they may lighten the work by dividing it between them, but the result is the same. In those cases where men have succeeded, they have had next to no assistance at all till the increase of business made it absolutely necessary, and the profits allowed it.

Then, assuming that the above is agreed to, that proprietors of small businesses are to be everything, like Pooh-Bah, difficulties crop up right and left when they come to put the principle into practice. Buying men like—it is one of the sweets of business, also one of its greatest dangers. But few men like selling, or canvassing, or collecting accounts, or facing irate contractees, whose non-satisfaction means heavy loss to the contractor. Selling is all very well when the buyer comes with a sweet smile and asks to be allowed as a personal favour to himself to buy, at your price, and to pay immediately. But buyers do not adopt that plan—at least, not when they mean to pay. The seller has to go to them, and to compete with other sellers, and sometimes to put up with very smart rebuffs from buyers who do not wish to be bothered just then.

Again, perhaps there is no more difficult part of a business than getting one's money in. If one happened to be the only seller, and certain people were obliged to buy, the matter would be simple. But sellers are many, and buyers are often not slow to change, if offended by want of tact on the part of the seller. Added to all this, the capital required in every electrical business, except in a few special cases, is very large indeed in proportion to the amount of business that can be done, as compared with other businesses, while incidental expenses are often very heavy. No matter what happens to an apparatus, if injured, the seller or contractor is usually expected to make it good. Even where he is not actually expected to do so, he cannot allow an imperfect apparatus to be in use, with his name attached, as it would lead to serious loss of business. People do not enquire why an apparatus has failed, they see it has failed, and go elsewhere.

Other sources of expense also constantly arise, which make it hard to realise a profit in engineering businesses. The very march of science is against the man who owns a business. Some new discovery is made, some great improvement in construction, and perhaps a large portion of his stock is reduced to the value of old metal. Where a man runs his own business he has to stand all those expenses himself. Where he is merely the engineer to a firm, or to a company, he does not, though he may have been mainly instrumental in causing a large portion of them.

Further, it is worth the consideration of young engineers,

whether it is wisdom to drop out of the race, unless they have reasonable certainty of reaching a good position on the other road. It is, of course, not always possible to keep in one employ, but the most successful men, in the truest sense of the term, are those who do. The man who gets into a sound concern at the beginning of his career, though he may have to accept a small salary, and who remains with the same firm, though he is perhaps not always getting sometimes as large a salary as those who graduated with him, will usually occupy a better, a more comfortable, position when advancing years render it of value to him, than the man who is constantly changing, as he thinks, to better himself. Firms do not always study old employes as they should, but there are few cases where continual service, supported by hard work and average ability, do not bring a substantial reward at the time it is most appreciated.

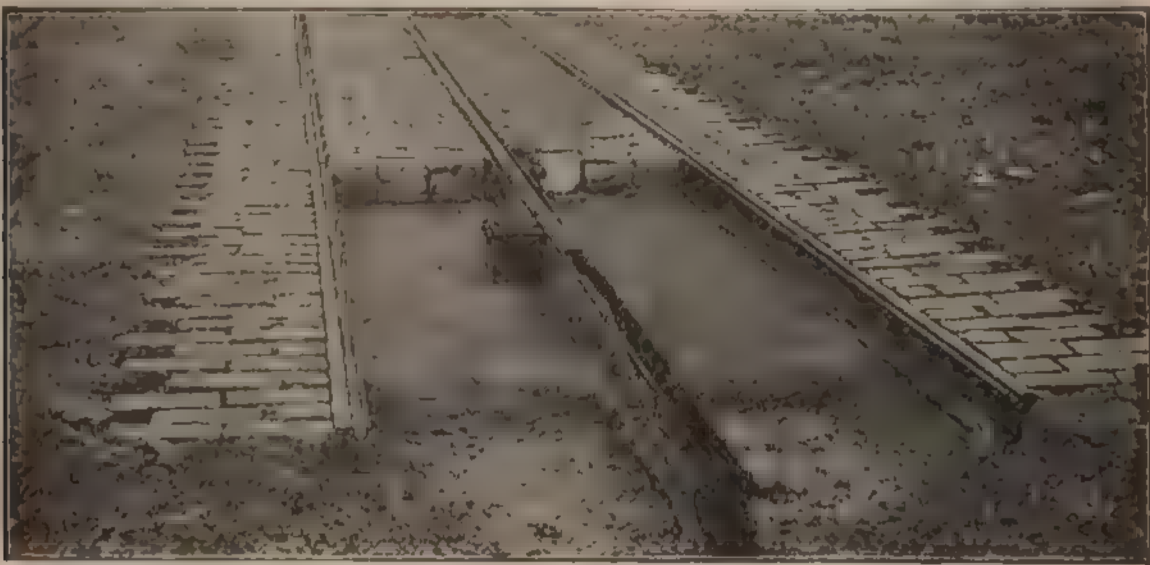


FIG. 1.

FIG. 2.

ELECTRICAL TRACTION ON TRAMWAYS.

THE "BRAIN" SYSTEM.

Never before the present time has so large an interest been manifested in the various systems of traction which have of late years engaged the attention of engineers. That a vast open field awaits the introduction of any really good system is best gauged by the eagerness with which those interested in our present tramway companies are investigating modern developments. Horses are expensive and slow, steam is more expensive and dirty, and they are now already convinced that the true course for improvement lies in the adoption of some form of transmission and distribution of mechanical power, as such would not only give a quicker service but increase the public use—a great financial gain—and if less expensive in working be of very great value.

It is generally felt that by the use of electricity the problem will be best solved. The electric accumulator system is very attractive, but wherever it has been used for any length of time it has proved too expensive, and many experienced authorities now strongly doubt if it can be made to pay. The overhead trolley system, which has been so successful in America, has thoroughly established the fact of the "economy" of electrical traction when operated by means of a direct connection to a line conductor. The inconveniences and objections to the exposed overhead wires prohibit its use in most cities, certainly in this country. An underground conduit is therefore the only resource.

Owing to difficulties experienced with those having an open slot, many proposals have been made for using a permanently sealed conduit with a series of short exposed contact rails and different methods for automatically connecting and disconnecting the contact rails and the main conductor, but none of these have been adopted. The great multiplicity of parts, the inaccessibility, and the

impossibility of fixing the various sections and buried parts in a manner capable of resisting the destructive action of the road traffic, appear to prevent them inspiring sufficient confidence.

The troubles experienced with the latter, which led to these proposed schemes, were the failures of the insulation during bad weather and the frequent breakdown of the thin insulating covering on the travelling connection which passed through the narrow slot to the conductor. By increasing the size of the conduit and other proper precautions, the difficulty with the main conductor insulation can to a great extent be overcome. This, of course, entails a proportionate increase in the already large capital cost of a conduit; but the frequent failure of the thin insulating covering, so disastrous to the regularity of the traffic, can only be prevented by the use of a slot wide enough to allow a much thicker covering.

A wide slot, at least 1in. wide, if not more, is therefore *sine quâ non* to maintain an uninterrupted supply of power to the car from the conductor in the conduit. In this country the authorities will not allow it. Moreover, it necessitates a much wider and deeper conduit to accommodate the extra dirt accumulation and prevent the exposure of the conductor, which again greatly adds to the cost. This is the only form in which the open-slotted conduit can be made practicable, but the sinking fund on the heavy capital cost becomes a large item in the total working expenses, and the wide opening in the street is most objectionable. Further, the construction of such conduits requires a great disturbance and deep excavation in the roadway, and even then the general inconveniences of these conduits, such as inaccessibility for repairs and renewals, the effect of ice and sleet in narrowing the slot, and many structural and working difficulties experienced with the conductor and the crossings, are still existing.

To summarise, the successful conduit must be primarily cheap, have a wide slot, and be small, thereby necessitating but little road disturbance. This is the practical issue of the past seven years' experience in street conduits.

The difficulty is to build such a conduit that would be unaffected by bad weather or dirt accumulations, and have a conductor never dangerously exposed. Now the system which is just being made public, known as the Brain "covered conduit," seems to secure these advantages. It is the invention of Mr. C. T. B. Brain, of Bell's-buildings, South John-street, Liverpool, an engineer and electrician of long experience in this work. He was for some time electrician to Messrs. Elwell-Parker, and as engineer has

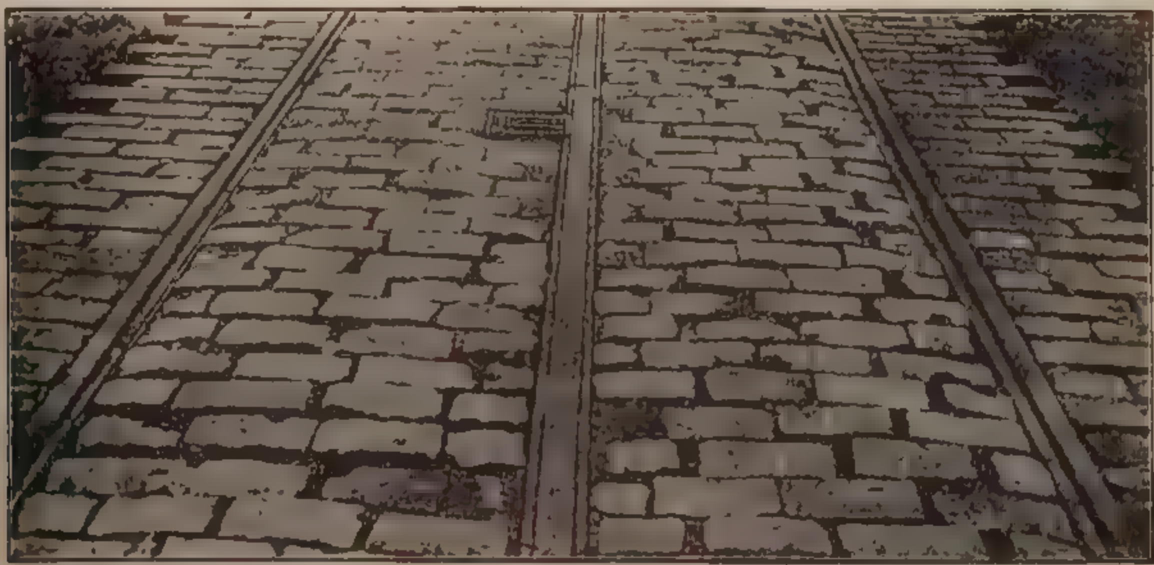


Fig. 3

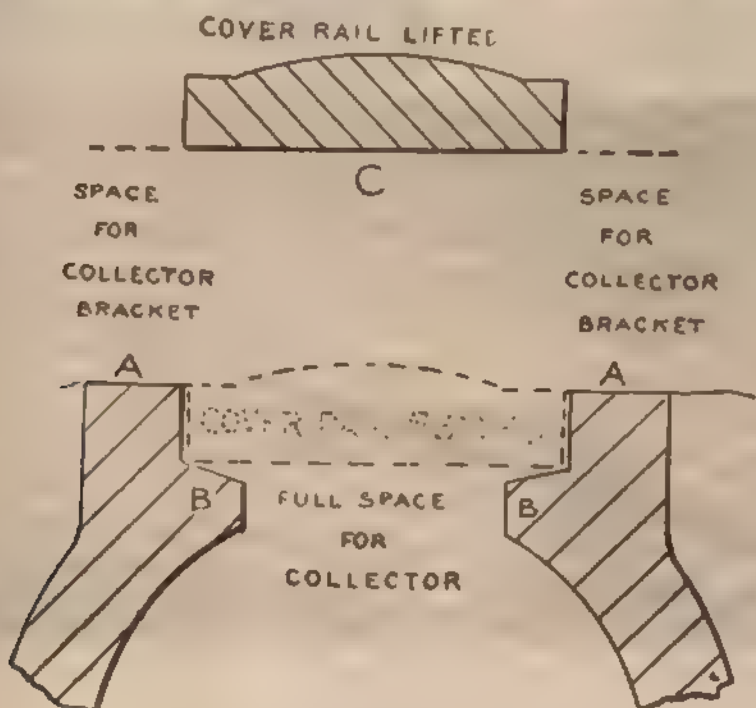


Fig. 4.

had responsible charges at the Portrush and Blackpool electrical tramways, where he successfully carried out various rearrangements. He has proved the system by a series of trials extending over the past two years. His conduit is small and possesses a wide slot; this is covered by a continuous rail, formed of stout flat steel bars joined end to end and called the cover-rail, which sinks flush with the road surface and rests upon a ledge or flange on each side of the slot, thus excluding the dirt and preventing dangerous exposure of the conductor, which is placed centrally underneath the rail.

Fig. 1 well illustrates the general construction. It will be seen that the conduit consists of simple cast iron troughing, laid in lengths, which firmly fit into each other, upon the existing concrete of the roadway, this providing a ready-made and substantial foundation. To obtain access for the connection between the car and the line conductor in the conduit, the cover rail is held up about 1½in. high by rollers underneath it and connected to the car, which we describe hereafter in detail.

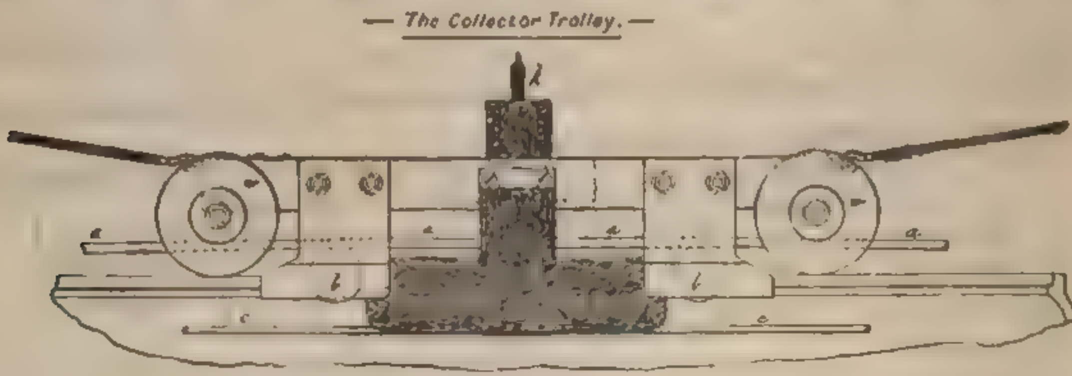


FIG. 5.

FIG. 6.

The most original and practical feature in the operation of this system is the manner in which so strong and heavy a rail returns to its seat on each side of the point of support. Fig. 2 is taken from a photograph of the actual bar used, showing it supported at one point in the middle of the view and the natural deflection which such a bar, lying on a continuous horizontal bed, makes when raised 1½in. high. This is the extent to which it is raised under each car. The cover rail is 2in. wide by $\frac{7}{16}$in. thick, and such a stout bar has but a very gradual deflection, returning to its seat at a distance of 4ft. or 5ft. on each side of the raised position. It is evident that with this section and so short a width the transverse strength of the cover is more than ample. It could bear many tons. Yet it has just sufficient flexibility lengthwise. As it does not weigh 3lb. per foot the maximum load carried due to the working of this rail cannot exceed 3lb. × 10ft. = 30lb. Fig. 3 shows the neat appearance and unobjectionable character of the conduit on the road surface, and also gives a good idea how the conduit is protected from dirt and flooding. Owing to the depth to which the bedded rail sinks into the seat and to its great rigidity in a horizontal plane, always retaining, even when raised, the shape in which it is fitted to the conduit, the action of the rail in returning to its seat is most certain both on straight lines and curves. In practice, as a safeguard this is still further ensured by a roller near each end of the car running on the unlifted rail before and behind the raised portion.

These points will be best understood by reference to Fig. 4, which shows a full-size section of the upper part of the conduit, the supporting ledges, B B, and the cover rail. This last is shown in its raised position, and an idea can be obtained of the space afforded for a large and strong connection to pass into the conduit opening, and of the general strength of all the parts, including the brackets carrying the lifting rollers under the cover rail, as well as of the small vertical depth occupied by the rail, its great transverse strength, and the neatness of the whole arrangement

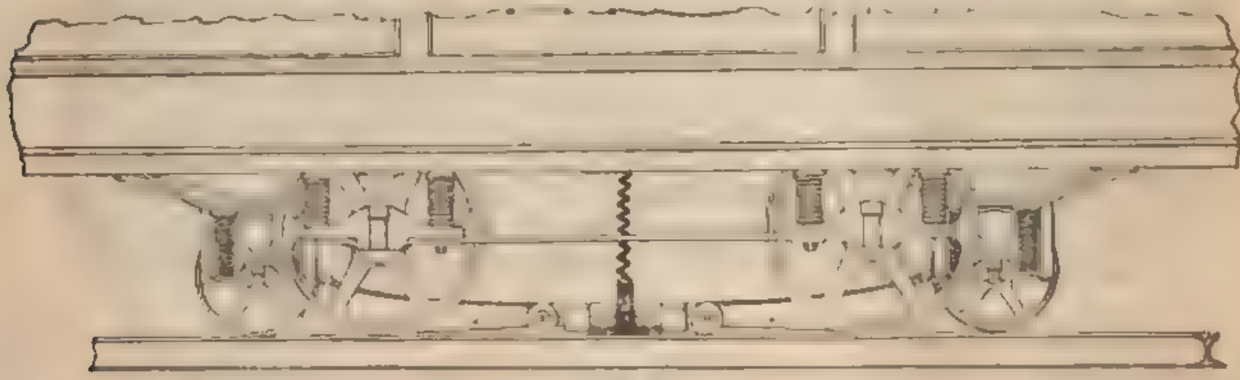


FIG. 7.

This travelling connection with its sliding contact in the conduit is called the collector. It is fixed to the brackets which carry the lifting rollers, there being two of these, one at each end of the collector, and they support the cover rail at C. The whole collector frame is in turn supported by a wheeled trolley, which runs upon the top edges of the conduit sides, A A.

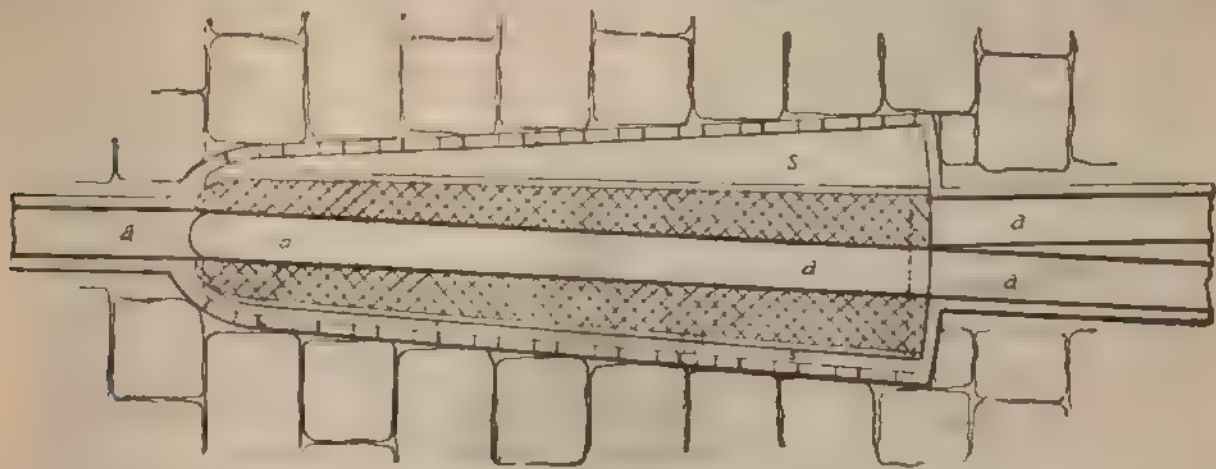


FIG. 8.

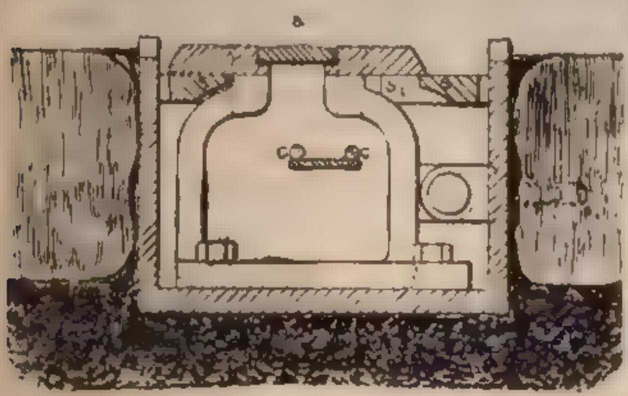


FIG. 9.

Figs. 5 and 6 are an elevation and detailed sections of this collector trolley, in which *a a* is the cover rail, *b* the lifting or carrier wheels, *c* the conductor, and *d* a flat conducting strip, which is the connection passing into the slot, *f* a contact grip, *g* the grip contact piece, *h* the hard insulating block or collector case, *k* flexible cable attached to car, *w* trolley wheels. The trolley is drawn by ropes hooked to each end, and it will be seen that the connecting strip, *d*, is held in a position midway between the surfaces of the cover rail and conduit, and the insulation, already strong, is not subject to the heavy wear and friction. The insulating block, *h*, has let into it a thin steel case like a lock frame, in which work the spring and strong levers attached to the contact-shoe shown in section and dotted in elevation. The grip contact is an insulated connecting plug, used as a convenient form of detachable connection. The car body and wheel base, together with the rollers running over the conduit, and the trolley in working position, are shown in Fig. 7.

The flexure of the cover rail is so very slight that the structure of the metal is in no way strained, its elasticity being so little taxed. The effort due to the operation of the rail is entirely confined to the weight carried and lifted. The weight carried is 30lb., and the rolling friction due to this requires a tractive effort of 1lb. or 2lb. Taking the rise at 2in. instead of 1½in., the weight lifted is 3lb. × 5,280ft. × $\frac{2''}{12}$ = 2,640 foot-pounds per mile, or a pull of ½lb., which with friction should also never exceed 2lb. The total power absorbed is therefore nominal. Even were the cover rail strained there would be no tendency to hog up, as in being lifted and replaced both sides would be in turn stretched. The joints are made to allow a small sliding movement, necessary for working and for expansion and contraction; and small fixed studs prevent the rail moving along the slot.

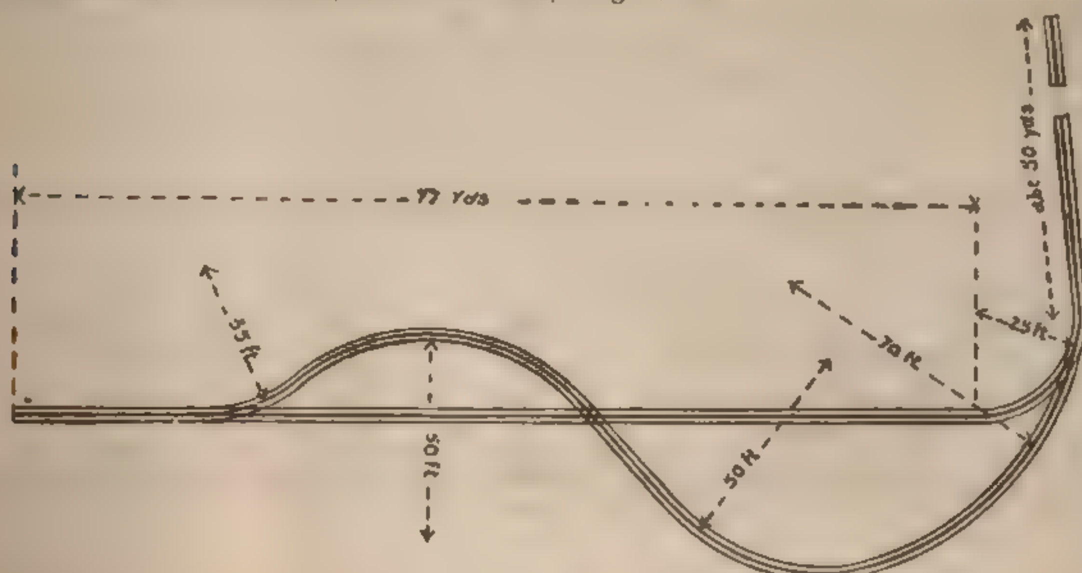


FIG. 10.

A considerable experience has been gained with the working of the rail which has thoroughly confirmed its practicability. Figs. 8 and 9 illustrate the way the cover rail is worked at the points or turnouts; *a a a* show ends of cover rail. At the fork of the conduits, the end

of the rail covering the single line has fastened to it by a stout pivot a short length of cover rail, *a a*, which can move like the points of an ordinary rail. The free end of this is grooved to fit tongues on the ends of the other rails, *a a*, and can be moved into connection with the rail covering the conduit of either route. This is effected by pivoted

Fig. 11

cover-plates on each side of it, which are fastened to a stout U piece passing under the conductor inside the conduit, and shown in the section, Fig. 9. They are made with a ledge on the inside similar to the conduit slot, and in these the rail *a' a* rests. To the U-piece is attached a rod which controls the crossing. Where facing points are used worked by hand, this is connected directly to and therefore must work with them. But in turnouts where the rail points are worked automatically by the car wheel flanges, a simple

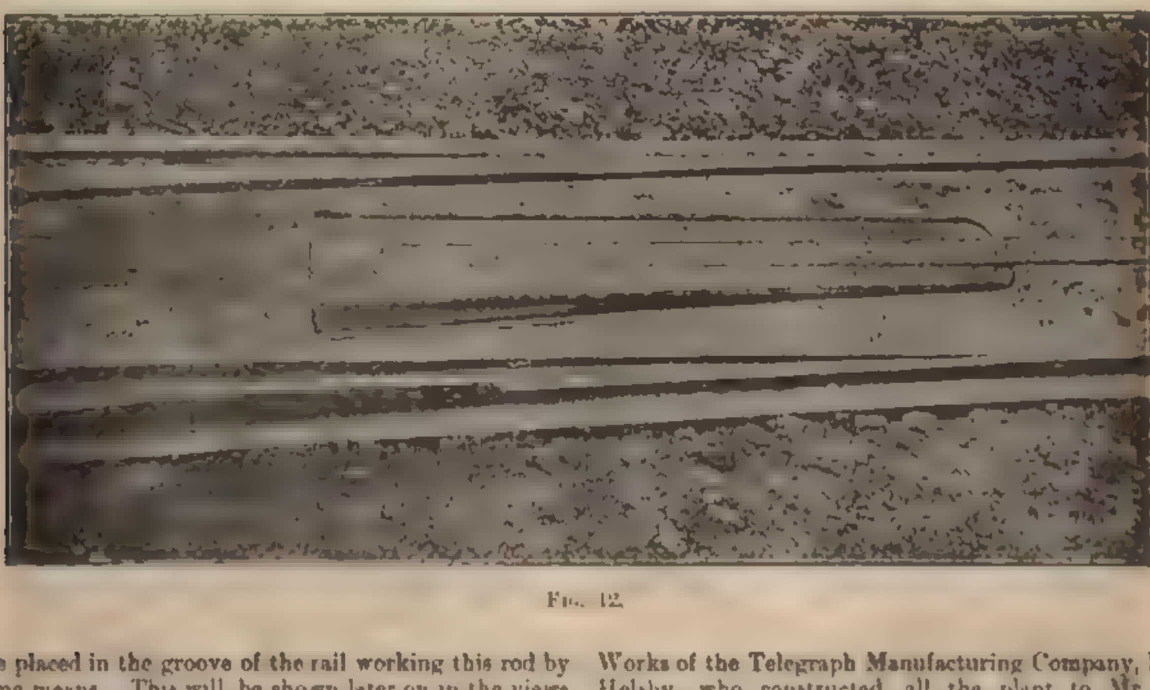


Fig. 12.

lever is placed in the groove of the rail working this rod by the same means. This will be shown later on in the views of the experimental plant.

The pivoted side plates not only cover the large opening and support the rail, but tongue down the end of the rail of whichever conduit is not being used, and make the sides of the slot continuous in the direction they are turned, causing the passage of the collector to be as uninterrupted and certain in action as on a straight line. It is here the advantage is seen of a central conductor with contact made on its upper surface. At the turnouts and all crossings the conductors can be made continuous, as at their junctions they are simply made to present a flattened surface over which the contact shoe can easily slide in either direction

In the account following of the practical work done with this system, a view is given of a crossing, constructed at a most awkward angle, in which the conductors are so fixed, and the cover rail, which in this case has a short bit swung round by a U-piece like a small turntable, is actuated similarly to the above. All the parts have been developed and thoroughly tested during the past two years on a designedly awkward experimental line of narrow-gauge track, but with full size conduit, laid at the Britannia Works of the Telegraph Manufacturing Company, Limited, Helsby, who constructed all the plant to Mr. Brain's designs. Moreover, all the various details and parts of the whole system have been worked out and reduced to standard patterns.

A reference to the plan of the line given in Fig 10 shows immediately the extent of the experimental trials. There is a long, straight piece, on which considerable

speed can be attained, terminating in a sharp curve of 25ft radius, the line then continuing straight at a little less than a right angle for some distance, allowing the curve to be rapidly traversed in either direction. From off the straight length there is a turnout with points made as abrupt as possible; it winds round with curves of 35ft. to 50ft. radii, and passes right across the straight track, cutting it at an angle of 45deg.; continuing, the lines join on the small curve, the two curved conduits meeting form a long, fine point.

Fig. 11 is a general view of this line looking up the straight from near these points, which will be seen at the bottom. Experienced engineers know the structural difficulties of yoking two conduits at such an angle, but with this system there is no long overhanging centre point, as the conduit is narrow and the slot wide. Fig. 12 is the top view of the cover rail and conduit at this junction, while Fig. 13 shows the abrupt turnout, on which the lever in the rail groove can be seen, and Fig. 14 is the centre crossing with the small circular turning piece in the middle, which operates the short connecting-piece of cover rail.

The small cost and mechanical simplicity of the system just meet the requirements of the problem. The economy of working a conduit system has been proved; it is the objectionable slot and inherent faults of the line, injuring the traffic, which have prevented its adoption even more than the great capital outlay required. But this capital involves upkeep, and it is now being realised that such engineering undertakings should have a sinking fund to meet the deterioration of the property. The percentage per annum required on this large capital depends very much upon the frequency with which the line has to be overhauled. This fund, as well as maintenance and repairs, is a part of the true working expenses, and the large proportion it becomes will be seen even in the case of Blackpool, where the conduit was built smaller than now found advisable with the open slot. It cost about £4,500 per mile, and this at only 5 per cent. equals over 1d. per car mile run per mile laid—more than maintenance or fuel, the latter being 0·7d.

The simple construction and working movement of this "Brain" system makes it most accessible for repairs. The cover rail as it sinks in its seat affords no hold on its surface for interference, but throughout its length can be easily and rapidly removed from its seat as fast as the car travels, by loosening a joint, setting the rail on one side, and putting the rear roller of the car out of place so as to

Fig. 13.

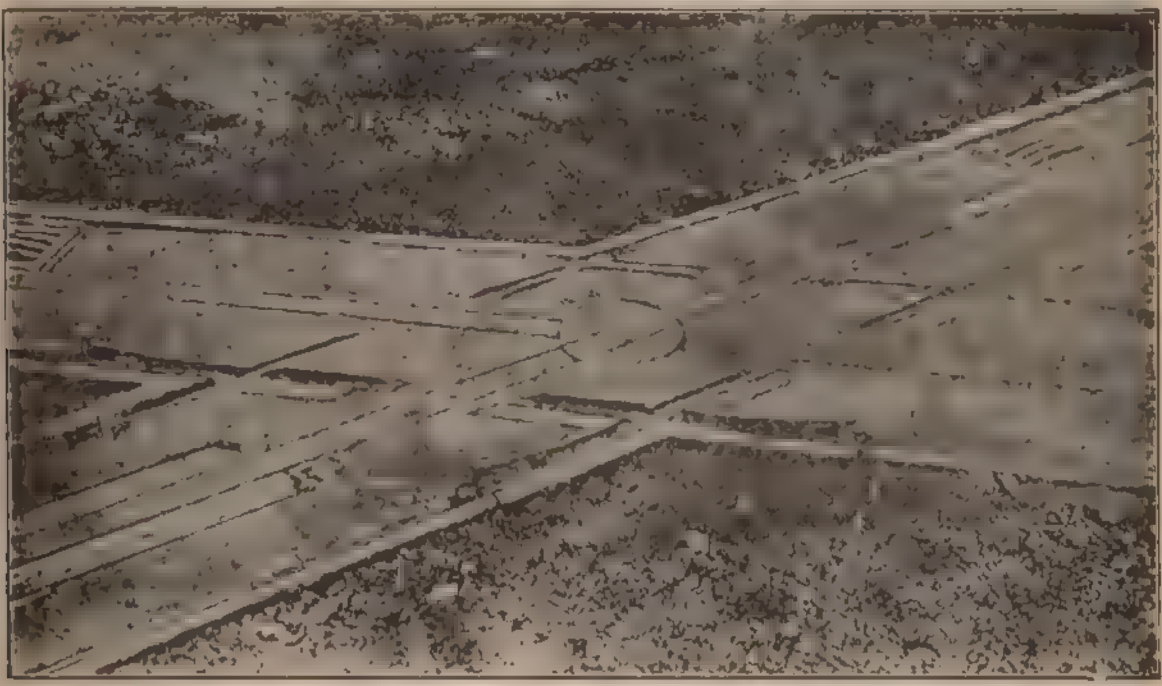


Fig. 14.

lay the cover rail on that side; running the car back replaces the rail.

In every way great economy appears possible with this system, and it warrants an extensive adoption.

THE

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THE LOAD.

Like the weather to the ordinary inhabitant, the load is to the electrical engineer always a topic of interest. There are, however, indications that the special topic will only be of temporary interest, while the weather, like the river, goes on for ever. We say the load is only a matter of temporary interest, and our reasons for this statement will be forthcoming. We know that Mr. Crompton, to mention one example, is among those who contend that our knowledge of central station work has not made those great advances we usually imagine it has. From one point of view he may be right, from another he is probably wrong. Circumstances alter cases, and our words must not be taken as universally applicable. With certain feelings of incertitude we would urge that even now we cannot satisfactorily say what is the best unit of central station, though we may be upon safer ground as to the unit engine and dynamo when we have decided upon a central station. By unit central station we refer to the station or stations to be erected for the lighting of a large town like Liverpool, Manchester, or Birmingham, and with electricity the sole artificial illuminant. At present most central stations run cheek by jowl with gas works. The former method of illumination is a luxury — a luxury undoubtedly permeating downwards, as all luxuries do when they decrease in price and maintain certain agreeable properties. Now, given the problem which must come sooner or later for the total lighting of some such large town, shall we instal our central station of gigantic proportions as large or larger than Deptford, or shall we instal several stations? If the latter, what is the best size of station for economical working and distribution? What in reality is the exact position taken by a central station generating current for a hundred thousand eight-candle-power incandescent lamps? It is wholly insufficient for the needs of a large town, yet there are few central stations that can boast of more lamps wired. According to the drift of present practice it seems preferable to erect several stations, but again comes the question, What is the most economical size? This being determined, we come to the simpler problem of unit combination. This latter is practically determined when lighting alone is under consideration by the load or supply curve, with one proviso that the unit be not so small as to be uneconomical. An engine of two hundred to three hundred horse-power will probably be as economical as one of a thousand horse-power. If an engine of less horse-power than this differs considerably in economy, it is clearly of importance to have a central station so designed that the full load of each successive unit is obtained as quickly as possible and maintained as constant as possible. We have taken the horse-power somewhat at random, inasmuch as the argument holds good whatever the unit adopted—it must be large or small enough to be economical, and to be fully loaded as long as possible during use. The full or light load upon the unit depends upon the size and arrangements of the whole station. With stations fully equipped, and with their full

complement of lamps wired, no unit ought to run long except under full load. This reduces loss. Of course, when we supplement use of current in other directions than lighting, we still further reduce loss, because all the units can be run constantly at full load, and no machinery is idle except that installed as a stand-by, or undergoing repair. Once more, it is not when Manchester, Nottingham, Liverpool, Birmingham, Bristol, Glasgow, and half a score of other large towns determine upon what we now call electric lighting that the question of unit stations will have to be solved, but when the system has percolated among householders so as to become the common method of lighting that the trouble will arise. There will come a time and a point when electricity will oust gas entirely, and the first opportunity may come any day. Distributing sub-stations will not solve the question, though distribution will really be the pivot upon which the solution turns. Meanwhile, the unit in any station should be so designed as to be working normally under full load. Our American contemporaries are struck by the load diagrams of central stations on this side showing what they kindly term Alpine Peaks, but they forget that the industry here has not so successfully induced users of small powers to employ electric motors as they have in some places on the other side of the Atlantic. We have always said too little attention is paid to power, and too much to light, but the argument against us is, Let us sell what the public want, and do not try to force that which they do not want.

TRACTION.

Elsewhere we describe fully Mr. Brain's conduit system for tramway work. It is truly hinted there that our adoption of electric traction is very slow, and that this slowness arises probably from the fact that the various plans adopted have not been the conspicuous successes their designers hoped. Accumulators, it is well said, have not so far obtained a footing. Cynical men say that really accumulators have never yet been tried. Certain samples—not altogether suited to tramway work, as working has shown—have, perhaps, been tried, but other and better forms have not had a look in. Some enthusiasts maintain that the best form of battery is one of the Planté type, that costs little, and may be worked out and thrown away for old lead. There is a good deal of plausibility in suggesting that a leaden battery costing, say, a couple of pounds, may be worked for six months, and at the end of that time go on the scrap heap for reworking up, its value for this purpose being thirty-five shillings. Accumulator traction has its field, on existing lines when self-contained cars are necessary or convenient. But it or any other system must be as economical as horse or mule traction. Sentiment is not business, and men will not, as a rule, pay a shilling for something they can get for tenpence. Again, overhead wires are not always obtainable though Glasgow seems to have come to the conclusion they may in certain places be tolerated. The conduit system will always command attention. If fairly cheap and efficient it possesses advantages over any other system, so that any new departure in this direction is sure of careful consideration. If, then, Mr. Brain has done all that he claims, he may be sure that any company entertaining the idea of electric traction will not fail to consider his plans.

VERDIER'S ACCUMULATOR.

Whatever the ultimate end of the lead secondary battery may be, it cannot be said that this type of electrical apparatus is being neglected by our present-day electricians. Our contemporary the *Revue Industrielle*, in a recent issue, contains a very glowing account of a new form of accumulator devised by M. F. Verdier, and which is constructed somewhat as follows: Litharge or minium, or other similar oxide of lead, is made into a thin paste by the addition of a vegetable oil or a mixture of glycerine and water. This pasty mass is then run into a frame or holder, made of some unoxidisable metal such as an alloy of antimony and lead. On being allowed to slowly dry in air, the lead salts become hard and of a cement-like nature. To increase the surface, and to allow for a free circulation of the electrolyte, all the plates are perforated vertically.

The plates are rendered active by being "formed" electrolytically in a bath consisting of sulphate of soda, or some alkaline salt which is soluble in a weak solution of glycerine and water. By this process the lead salts are reduced to the condition of spongy lead, and they are then fit to become the negative elements of the battery. The peroxide plates are said to be readily formed by immersing the reduced spongy leads, prepared as described above, in a bath of dilute sulphuric acid, and then subjecting them to electrolytic action for a few hours.

When building up complete cells the elements are disposed horizontally, that is to say, one above another, after the fashion of a Venetian blind. Insulating strips are placed between each plate, and the whole system of elements is held rigidly together by means of stout indiarubber bands. Connecting wires are carried from the metallic containing frames, which hold the active material, and those of like polarity are joined together by a suitable clamp, which forms one of the terminals of the battery.

Several types of the Verdier cell are made, and these contain respectively, five, seven, nine, and 11 plates. The elements in the nine-plate type, which is said to have a capacity of 400 ampere hours, weigh 20 kilogrammes, and each plate has a surface of 400 square centimetres. The elements in the 11-plate cell are smaller, and weigh collectively 6 kilogrammes, and have a current capacity of 125 ampere hours. The active surface on each plate of the latter cell is 100 square centimetres.

In the new cell it is said that the ratio between the active material and the gross weight of the elements may vary between 25 to 75 per cent., according as to whether the cell is constructed for high rates of discharge, or to withstand rough treatment. The ordinary commercial form of cell is stated to contain 60 per cent. of active material, and will give 20 ampere-hours per kilogramme of plate.

Some tests of the Verdier cell have been made by M. de Nerville in the Central Electrical Laboratory of Paris. From a test made on August 31st, 1891, the following results are taken: A cell weighing 6·8 kilogrammes, and containing five plates whose total weight was 2·4 kilogrammes, was fully charged and then discharged. The charging rate was one ampere per kilogramme of plate, and the discharge was made at 2·5 amperes per kilogramme. The result gave a current capacity of 32·08 ampere hours per kilogramme of element and with a fall of potential of from 2 to 1·85 volts.

Two other discharges of the same cell made with varying rates of charge and discharge gave the following results:

First Charge.

Mean rate of charge per kilogramme of plate.... ..	0·8 amp.
Total amount of current put in	81·5 amp.-hrs.

First Discharge.	
Mean rate of discharge per kilogramme of plate	1·0 amp.
Total current output	67·5 amp.-hrs.
Capacity per kilo. of plate	28·12 ,,
Second Charge.	
Mean rate of charge per kilogramme of plate	6·8 amp.
Total amount of current put in	85·0 amp.-hrs.
Second Discharge.	
Mean rate of discharge per kilogramme of plate	2·8 amp.
Total current output	58·5 amp.-hrs.
Capacity per kilo. of plate	24·37 ,,

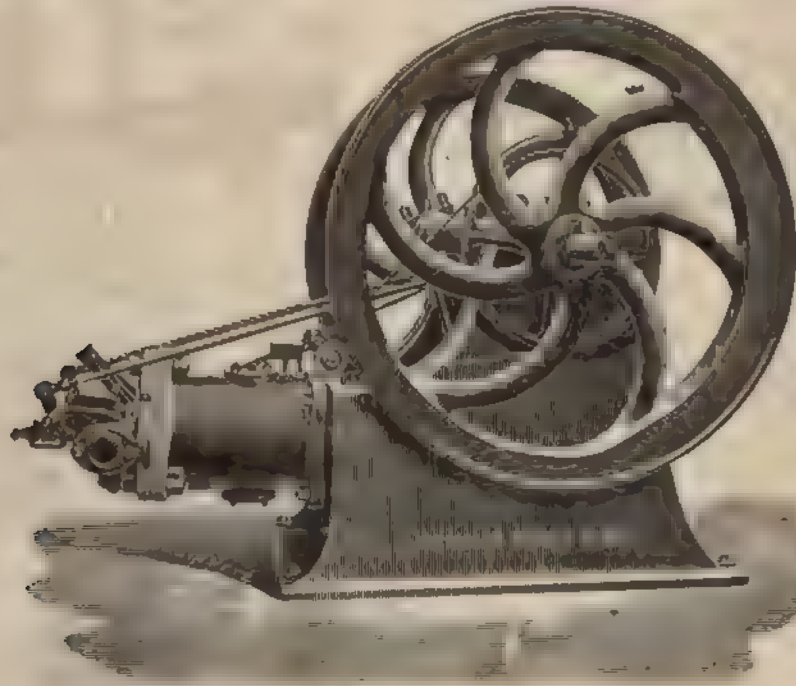

Fig. 1.

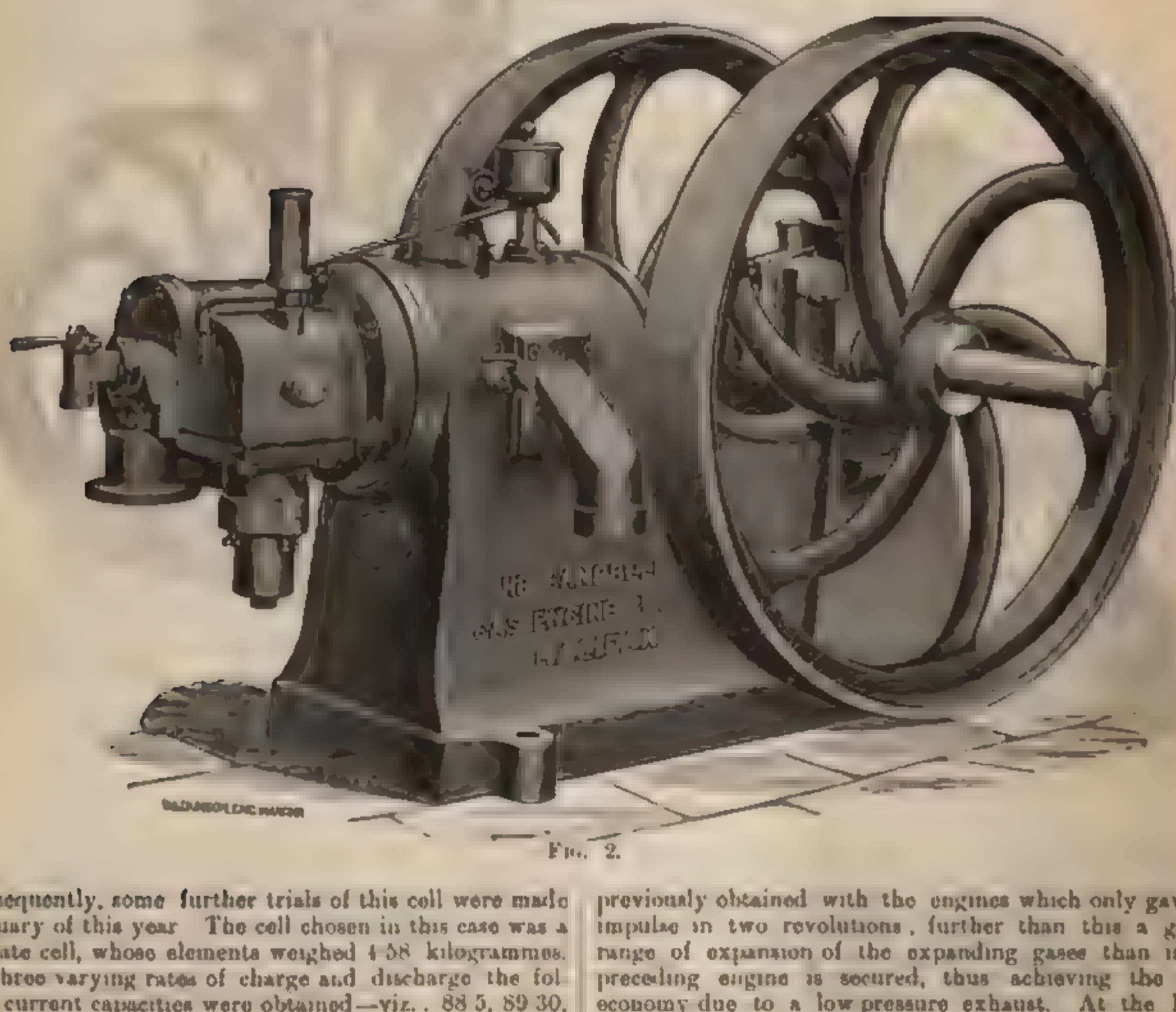

Fig. 2.

Subsequently, some further trials of this cell were made in January of this year. The cell chosen in this case was a nine-plate cell, whose elements weighed 4·58 kilogrammes. With three varying rates of charge and discharge the following current capacities were obtained—viz., 88·5, 89·30, and 92·0 ampere-hours respectively.

If these figures are reliable, there is yet some hope for the poor user of secondary batteries.

STEAM AND GAS ENGINES AT THE ELECTRICAL EXHIBITION.

Amongst the gas engines the cycle engine of the British Gas Engine Company will long remain one of the most mechanically interesting, on account of the mechanism by means of which four strokes of different lengths are obtained to one crank revolution, so that an impulse for every revolution of the crank is secured with all the advantages previously obtained with the engines which only gave one impulse in two revolutions; further than this a greater range of expansion of the expanding gases than in any preceding engine is secured, thus achieving the great economy due to a low pressure exhaust. At the Palace Exhibition two of these engines were employed in driving a number of lights, one of the engines is shown by the annexed engraving, Fig. 1, from a photograph. The prin-

ciple upon which this engine is constructed is one which in mechanical application differs from all others. Attempts have been made to arrive at similar results by simpler means, but no one has yet succeeded, and unless Mr. Atkinson takes the task in hand there does not appear to be much probability of its being accomplished.

The Campbell gas engine, of which several examples were shown, is a well made engine. An exterior view of one of these engines is given in Fig. 2, and

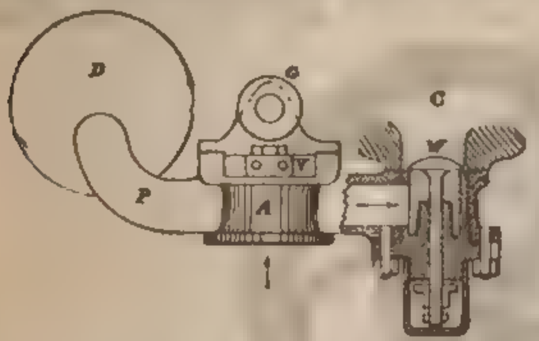

Fig. 3.

in Figs. 3 and 4 are views of the valve gear. The working piston of these engines receives an impulse at every revolution, a result which is secured by the employment of a second cylinder which, being provided with a piston, acts as a pump. This pump takes in a given quantity of air and gas, and on its instroke slightly compresses it and forces it into the working cylinder just as near the flywheel in Fig. 2. On its outstroke the piston in the pumping cylinder D, Figs. 3 and 4, draws in air through the chamber A and the pipe P, Fig. 4. On its way from the chamber A, through the pipe P, it passes through a port shown above A, Fig. 4, covered by the slide valve, V. When the engine requires a charge the finger F,

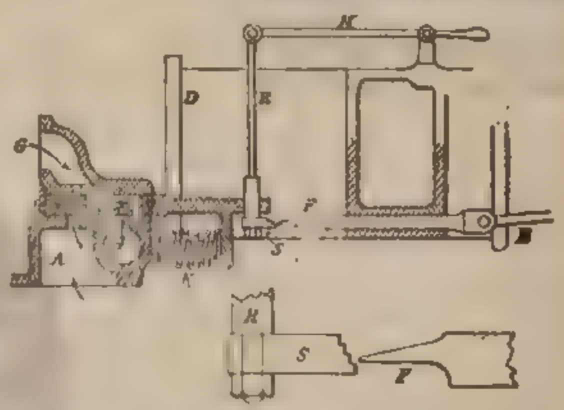

Fig. 4.

actuated by the eccentric rod E, comes into contact with the stepped piece S, which is held in a position, such as is shown at Fig. 4, by the governor rod R, which operated by the lever, H. The stepped pieces and finger F are shown to an enlarged scale below, Fig. 4. When the engine requires a full charge—such as it would get with the step-piece raised to the position shown—the air port

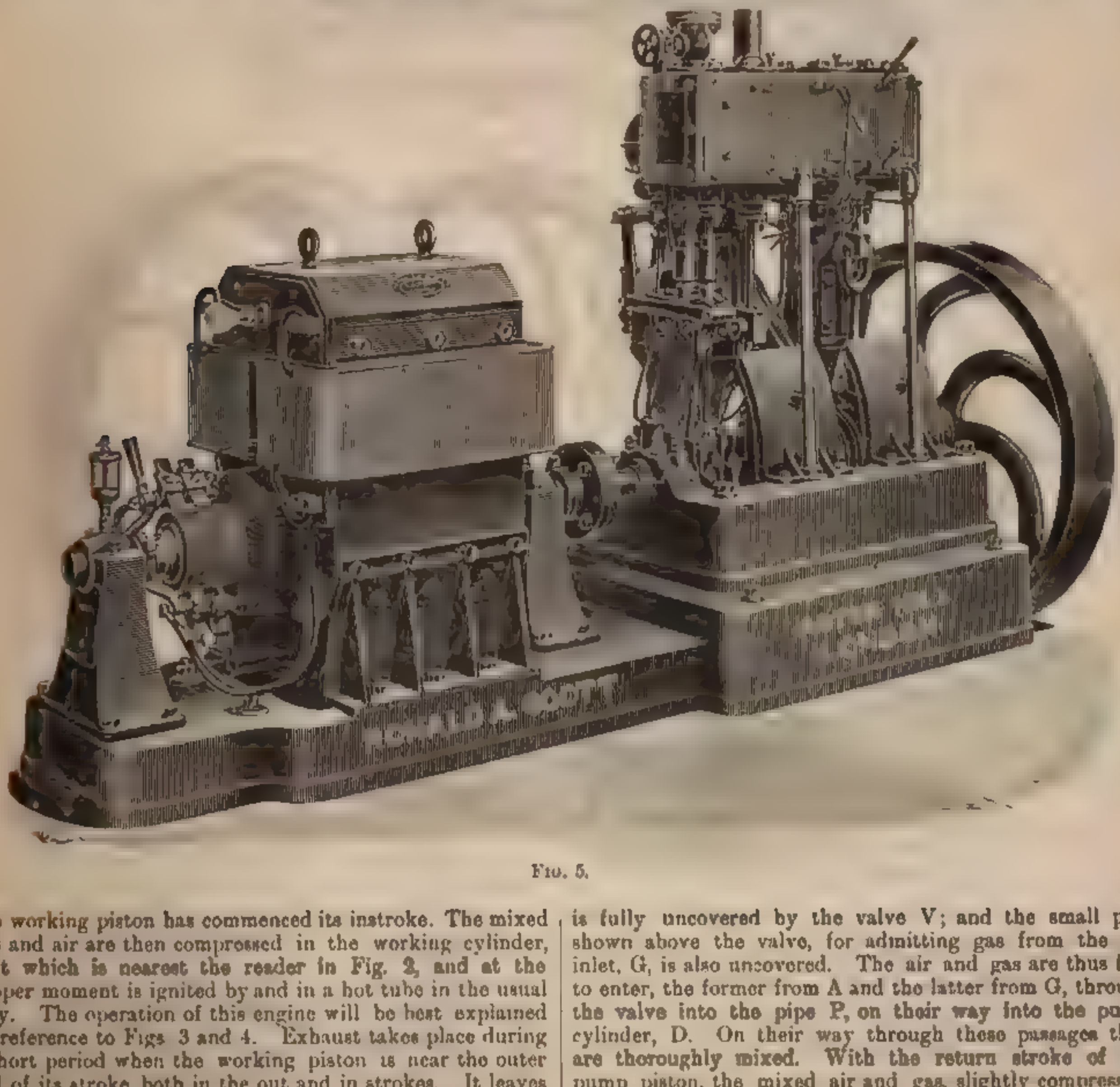

Fig. 5.

the working piston has commenced its instroke. The mixed gas and air are then compressed in the working cylinder, that which is nearest the reader in Fig. 2, and at the proper moment is ignited by and in a hot tube in the usual way. The operation of this engine will be best explained by reference to Figs. 3 and 4. Exhaust takes place during a short period when the working piston is near the outer end of its stroke, both in the out and in strokes. It leaves the cylinder by a port covered by the exhaust nozzle, seen is fully uncovered by the valve V; and the small port shown above the valve, for admitting gas from the gas inlet, G, is also uncovered. The air and gas are thus free to enter, the former from A and the latter from G, through the valve into the pipe P, on their way into the pump cylinder, D. On their way through these passages they are thoroughly mixed. With the return stroke of the pump piston, the mixed air and gas, slightly compressed, pass through the pipe P and into the working cylinder

through the valve W. The relative positions of the working and pump pistons are so chosen, that the charge from the pump enters the working cylinder before the exhaust-valve closes and has time to drive out some of the residual products of combustion. Those products which remain do no harm, because they are next the piston and do not affect the combustion of the explosive charge. The governor of this engine is of simple form, but is not shown in our engraving.

Mr. Ronald A. Scott exhibited the combined engine and dynamo, as shown by Fig 5. They were employed in supplying current to two powerful search lights, experiments with which attracted a great deal of attention. The combined plant is for 12 units output—150 amperes at 80 volts and were fixed in stand No. 47 in the Machinery Court. This is a very compact little plant, and the good governing is attested by the varied load put on. In addition to the search lights, the dynamo supplied 16 incandescent lamps and two motors, and occasionally a third search light. The engine is one of Messrs. Davey, Paxman, and Co.'s compound vertical "Windsor" type engines of about 25 i.h.p., fitted with Paxman's automatic expansion gear, and runs at 280 revolutions. The dynamo is constructed with fieldmagnets of soft wrought iron machined all over, and with a section of 133 square inches. The magnetic leakage is reduced to almost *nil* by mounting the field limbs on gun-metal brackets, at a distance of 6in. above the iron bed-plate. The armature is drum wound, and consists of 192 copper bars with end connectors, and a commutator of 96 sections. The end bearing is mounted in a spherical self adjusting plummer block, and the bearing surface is Magnolia metal. The floor space occupied by this coupled plant is 8ft. 6in. by 3ft.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

I.—EVOLUTION OF ELECTRICAL ENGINEERING.

Repeal of the Act of 1882.

The repeal of the Electric Lighting Act of 1882, which was chiefly brought about by the efforts of Lord Thurlow in 1888, marked the beginning of a new and bright future for the electrical industry. Hitherto, its progress was terribly burdened by the old Act, this Act was hastily passed and put into force by Parliament in 1882, during the electric light mania, and was intended to protect the public against the wild and indiscriminate investment of money in swindling companies that were floated by the dozen. The protection took the form of empowering the local authorities to purchase the plant of the enterprising company at the end of 21 years, whether the company were agreeable or not, without being bound to pay the latter anything for the goodwill or source of profit, or increase of value, of the undertaking. But the bane of the Act was soon felt, for it totally crippled the electric light industry, so far as public supply was concerned. The golden stream ebbed back from an industry that was made so doubtful of remuneration, and electric lighting was starved through want of capital. Yet it is said that "out of evil comes good," but the only good apparent is that whereas a few years ago towns might have had poor and ill designed plant put down, now electric plant and apparatus has reached a high state of perfection, the light and the system of distribution is better understood, and lastly, the advent of the high tension alternating-current system has supplied a wonderfully elastic means of distributing light and power over large areas, a problem which cannot be well solved by low tension currents. The repeal of the Act in 1888 increased the term of compulsory purchase to a period of 42 years, thus doubling the length of time, this was the chief alteration, and it was one of incalculable value to the industry. The immediate effect of this acted as a great fillip, and the dormant energy that had been extant, soon showed itself in four short years. The increase of the electrical trade has been phenomenal, and the basis of a new and important industry firmly established on sound foundations.

Electricity in England and Abroad.

Let us look around and see what position electricity occupies, and what progress it has made in various parts of the world; no account will be taken of the telegraphic or telephonic industries, but only the utilisation of electricity for lighting and motive purposes.

America takes the first place in the electric light and power industry, the towns there being lit up by the score, and there are very few towns indeed that do not possess a central electric light and power station for distributing same, the electric light over there being as prevalent as gas. They adopt a better standard of light, but we in England are accustomed to have a few dim gas lamps every 40 or 60 yards, which just suffice to make darkness visible. Probably the Britisher thinks it is a vast improvement to have light of any description in the streets of a town, for a century ago towns had no light scarcely, except what was eked out by the dismal oil lamp. An American reckons a good street light as valuable as a policeman, and no doubt he is right.

Coming now to the application of electricity as motive power, there are now above 450 tram lines worked by electricity, having a total length of track of 3,600 miles, and employing upwards of 6,000 motor cars. During the last year 250,000,000 passengers were carried, the aggregate number of miles traversed being 50,000,000, and the amount of capital invested was 60,000,000dols., or £12,000,000.

The following figures show the extraordinary development of electric tramways:

Year	Lines.	Motor cars
1884	1	
1885	3	13
1886	5	39
1887	7	81
1888	32	265
1889	104	965
1890	126	2,000
1891	405	5,100
1892	550	7,500

The above statistics refer only to one system or method of working the lines, that known as the "overhead system," because the car receives its current by a trolley wheel rubbing along a wire suspended over the top of the car. This is the system mostly adopted in the States, although there are a number of other lines worked on other systems, such as by accumulators, etc., and of which no figures are given. By far the greater part of the overhead system is run by two companies, the Thomson Houston and the Edison.

The Thomson Houston work 231 lines, and supply 4,575 motor cars for 2,642 miles of road, while the Edison run 179 lines, and supply 2,100 motor cars. The rest is run by several minor companies. It may be mentioned that the system used by the Edison Company is that known as Sprague's.

The greatest tramway, or street railway, system in the world exists at West End, Boston, Mass., originally worked throughout by horse power. Electricity is fast superseding horseflesh as a motive power, and in the summer of 1891 one fourth of the entire mileage was worked by electricity on the Thomson Houston system, 542 motor cars working over 112 miles of road, and before long the whole will be worked by electricity.

To show how matters electrical thrive in Yankeeland it may be mentioned that the capital of the Thomson Houston Company stands at 10,000,000dols., or £2,000,000, and is credited with being the most powerful electric company in the world; and since one half of the total arc lamps in the States are supplied by this company, and the same with regard to the electric traction plant, not much more can be desired as proof. The rise and growth of this enormous concern well illustrates in a practical and commercial sense the phenomenal advance of electrical science, just as the prosperity of a manufacturing nation is judged by the quantity of sulphuric acid it consumes. In 1885 there were only about a couple of hundred men employed, now the works at Lynn, Mass., employ no less than 4,000 to 5,000, and the valuation of plant erected by them in the States comes to something like 70,000,000dols., or £14,000,000, distributed over 700 central stations.

The Edison General Company follows close behind the

Thomson-Houston in magnitude and importance, and the great event in electrical industrial circles has been the amalgamation between these two great companies: this was effected in the beginning of 1892, and thus forms a gigantic electrical trust, with a capital of 50,000,000dols., or £10,000,000, capable of controlling a monopoly of the greater part of the electric industry in the States.

A great problem now occupying the attention of electricians and engineers is the utilisation of the Niagara Falls, millions of horse-power there running to waste year after year. Hitherto this vast source of power has been unavailable, and its utilisation to produce electricity will be one of the greatest practical achievements in the domains of electrical science. It is proposed to transmit the electricity generated to Chicago and other large towns, there to be employed in lighting the streets and houses, driving machinery, propelling street cars, etc.

Turning our attention towards our own country we cannot but be struck in observing the disparity existing between the two. London is the only place where electricity enters to any degree into the commercial world; even in the largest city in the world, the heart and core of business and finance, the light is confined to the wealthy classes, so far as private dwellings are concerned, although it is freely used now in theatre, restaurants, hotels, clubs, etc. Still it must be admitted that enormous advances have been made in London during the last three years. Since the repeal of the Electric Lighting Act of 1882, every district in the metropolitan area is allotted out to some electric light company, and, furthermore, every district has now got a central station put down and at work. Whatever the English do, they do thoroughly and solidly, choosing their own time and weighing everything carefully before committing themselves, and as the individual is, so is that larger individual, the corporation or local authority, but when once on the move, nothing but the most substantial and approved work will suffice.

A short time back the towns possessing central stations could almost be counted on the fingers. A great wave of electrical activity has now begun to pass over England, and city after city, town after town, is up and doing. This activity among local authorities, etc., has broken out suddenly like an epidemic, and it will not be very long before England leaves America far behind, if comparison be made on the score of size.

The lighting of the City of London was a great and decisive step towards showing that the time had arrived for local authorities to seriously consider the advisability of adopting the electric light as a better means of illumination. The lighting by gas in the City gave an aggregate of 35,000 c.p., the ordinary jets used being about 14 c.p. to 16 c.p., while the larger jets gave about 40 c.p. to 50 c.p., five cubic feet per hour being consumed by the small jet, and 15 cubic feet per hour by the larger jet. The above quantity of light is now being replaced by arc lamps of 1,000 actual candle-power in the main thoroughfares, and by incandescent lamps of 25 c.p. to 50 c.p. in the side streets, alleys, etc., The increased cost of lighting by electricity is almost double that of gas, but it must be remembered that in the former case much more light is given. The undertaking is in the hands of a company which was formed to take over the concessions granted to two eminent electrical firms—namely, the Laing, Wharton, and Down Construction Syndicate, and the Brush Company; the former using their Thomson-Houston system, and the latter using the Brush system. Besides the street lighting, a compulsory area is mapped out, and mains for private house supply are bound to be laid down in this fixed area within a definite time. The private supply is by high-tension alternating currents, this method being adopted by both the above contracting firms on their respective systems. The City is divided into three districts; of these the Thomson-Houston system is used in the eastern district, which is east of the Mansion House, Princes-street, and Moorgate-street, where the private output will be for 4,800 kilowatts, or over 75,000 glow lamps of 16 c.p., and the street lighting for 900 arcs, while the Brush system is used in the western and central districts.

In London the Vestry of St. Pancras has the honour of being the first to adopt the electric light in the streets in place of gas, and also the first local authority to erect a central electric light and power station, supplying current both to their own street electric lamps and to the private houses. The streets are lit by 90 arc lamps of 1,000 actual candle-power, of the Brockie-Pell type, and placed at distances varying from 160ft. to 245ft. apart, suspended on steel poles 25ft. high. The private supply to householders is met by having machinery capable of running 10,000 glow lamps of 16 c.p. each, the whole output of which was taken up within six months after erection of the station.

The following tabulation shows the number of lights used in London:

Company.	Lamps in use, 8 c.p.
London Electric Supply	90,000
City of London Electric Light	23,000
Westminster Electric Light (three stations)	137,000
House-to-House	25,000
Chelsea Electric Light	30,000
St. Pancras Vestry	10,000
Kensington and Knightsbridge (two stations)	50,000
New Cadogan	10,000
St. James and Pall Mall	60,000
Metropolitan Electric Light	97,000
Electricity Supply	25,000
Total	557,000

The subject of lighting in London cannot be left without mentioning the gigantic scheme at Deptford. There Mr. Ferranti, the originator, contemplates using engines and alternators of 10,000 h.p. to transmit electricity from Deptford to London, at an electrical pressure of 10,000 volts, three trunk lines being used, which pass over the river by way of three railway bridges, thus feeding three different points. The 10,000 volts at these three points are then transformed down to 2,500 volts, at which electrical pressure the distributing mains are worked. A second transformation down takes place before the current enters the consumer's house, where it is brought down to 100 volts, the usual voltage for glow lamps. The magnitude of the scheme may be imagined when it is stated that the generating plant will be, when fully equipped, sufficient to feed 2,000,000 glow lamps. Unfortunately an ambitious undertaking like this, on such a vast scale, presents enormous difficulties, which swallow up a great amount of time and money, but the London Supply Corporation have stuck well to their guns throughout, believing firmly in their talented engineer, and, in spite of the disasters which have overtaken them, success is already beginning to crown their efforts.

The demand for current in some districts, for a long time has greatly exceeded the supply, as the various companies cannot extend their mains quickly enough. Some householders have had their houses ready wired for months, and, like Patience on a monument, wait until the supply company's mains get laid near their door. Great complaints naturally arise from this; sometimes it is the fault of the supply company through backward state of work, but mostly it is due to the importunate solicitations of the house-wiring tout, who, to secure the order for wiring, victimises his hoped-for customers by assuring them with the most barefaced plausibility that the supply mains will be down at his door by the time the house is ready. The householder is, therefore, strongly advised to take timely warning. Before putting your house into the hands of any stray individual, first see that the supply mains are already laid down, or being laid down close by you, or, at all events, within such a distance that the supply company, upon being asked, will join you on, then, and not until then, you may have your house wired without experiencing any of the heartburning and vexation in spirit from which so many are at present suffering.

In the provinces progress is not so rapid, yet there is a steady increase going on which is very satisfactory. Several of our large towns, such as Dundee, Glasgow, Bristol, Portsmouth, Nottingham, etc., have voted large sums of money for the establishment of central electric light and power stations.

Corporations, as is well known, are slow to move, and probably most of them have been waiting to see what the metropolis would do; now that the centre of the metropolis, the City, and the Vestry of St. Pancras have the streets publicly lit, the provincial authorities are beginning to think they can safely follow in their wake.

(To be continued.)

BADT'S ALTERNATING-CURRENT ELECTRIC RAILWAY SYSTEM.

The apparatus for conveying power to electric motor cars by underground conductors, which is illustrated by the accompanying cuts, is the invention of Lieut. F. B Badt, of Chicago, who proposes to use alternating or multiphase currents for this purpose. It is proposed to transform the current in step-down converters located at short distances apart, using two surface conducting rails, connected with the secondary coils of the transformers, to conduct the current to the car motors by rolling contacts. It is, however, possible to make one transformer answer for a considerable extent of track by using suitable switching arrangements. The conductors are to be laid in sections insulated from one another, and an automatic switch is provided by which the rails next in advance of the car will be thrown into circuit in time to furnish the working current as soon as the car has moved over them in the proper position, and cutting it off after the car has passed By this device, it is claimed, the conducting rails will only be in circuit at the time of the passage of a car.

Fig. 1

Fig. 1 gives a diagrammatic view of the parts of the apparatus in their relative vertical positions, while Fig. 2 shows an enlarged detail of a transformer and its associated parts. Referring to these cuts, A is an underground cable containing two conductors. The cable proper is composed of successive sections, each of which is securely let into the side of the box E by means of the stuffing-box, D. Within this box the main conductors are bared, and from them lead the terminals of the primary coil, F, and in opposition to the secondary coil, H, whose terminals led through stuffing-boxes into the switchbox, K. The two cover-boxes may be tightly filled by means of the funnels, L L, with oil to assist insulation In the box K is located the switch consisting of an electromagnet, M, which is included in the local circuit composed of the conductors, M[1] M[2], leading, respectively, from the sectional rails, M[4] M[4] (Fig. 2)

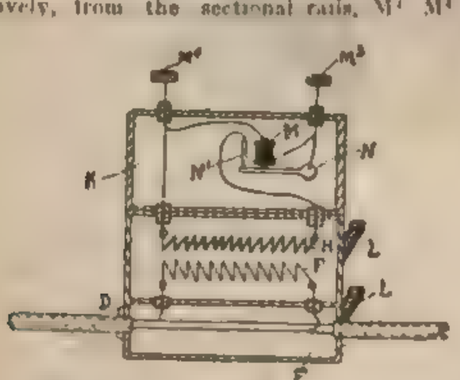

Fig. 2.

Opposed to this electromagnet is the pivoted armature, N, normally disengaged from the contact block, N[1], which forms one extremity of the conductor which leads from the secondary converter coil The other conductor, O (Fig 1), from the secondary leads to the sectional rail M[4]. The armature, N, may be held away from the contact point N[1] by spring, gravity, or otherwise as may be convenient. The rails M[4] M[4] are made in successive fairly well insulated sections laid upon the surface. These sections are, preferably, slightly less in length than the distance between the trolley wheels, R R and S S.

In the underground cable it is proposed to use currents of 2,000 volts potential, or higher if desired, to be transformed down to 50 volts. If for any reason the local circuit is closed, no particular loss of current will ensue, for insulation sufficient to confine a current of such low voltage in the sections of conducting rail can easily be obtained. Moreover, if by any possibility a local short circuit should be completed, small damage, if any, would be done on account of the low voltage of the local current. Suitable fuse-plugs would be placed in any or all of the circuits or connections, as desired, for the purpose of ensuring safety, and the car is preferably provided with two motors, though more or less could be used, and with two sets of trolley wheels. One set will be placed forward on the car and the other toward the rear. The conductor rails or strips are preferably arranged between the tracks or rails on which the car is supported and consist each of successive sections insulated in the ordinary manner and so far as may be convenient from each other.

Various means may be devised for closing the switch in the first instance to start the car, as, for example, a storage battery cell or two may be associated with the car. Assuming that current taken up by the forward trolleys is being passed through the motors on the car and through the magnet of the switch to hold its armature up and the circuit closed, the car will, of course, tend to move forward under the action of its motors. Its forward motion speedily carries the forward trolleys towards the next succeeding set of conductor rails or strips. The rear trolleys will, however, at such time necessarily be on the set of rails or strips in the rear of those against which the forward trolleys act. This current is being supplied to operate the car and to keep the rear rail sections in circuit through the rear trolley. At the same time the forward trolleys, being connected, as shown, with the rear trolleys, a circuit is closed through the switch associated with the next converter, and a sufficient current is diverted through such circuit to close the switch or lift up the armature and complete the circuit through the secondary coil of the forward converter. This brings the forward trolleys into circuit, and they lead a current through the motor or motors of the car. When the rear trolleys pass off of the set of conductor rails on which they are acting, they will of course cause the release of the switch and the local circuit connected with these rails will be broken; but before this action takes place, since the conductor rails are somewhat less in length than the distance between the trolleys, the forward trolleys will have passed on to the second successive or forward conductor rails, and will have brought them into circuit, and the current will be supplied through them, as last above described.

The system with some modifications is applicable to conduits already laid. Lieutenant Badt has also devised a mechanical switch for this system by which the current is turned on and off by means of projecting pins from the trolleys. The advantages of the invention are the absence of overhead wires, the presence of the current in the surface conductors only when the car is over them, and the low voltage employed in these rails. The principal defect of the system is the lack, at the present time, of a satisfactory alternating-current motor adapted to street car work, but when this want shall have been supplied Lieutenant Badt's invention will no doubt be thoroughly investigated by practical tests.—*Western Electrician.*

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION *

BY PROF. GEORGE FORBES.

LECTURE I.

(Continued from page 244.)

CENTRAL STATION SUPPLY v. ISOLATED PLANT

At the date of my previous Cantor Lectures the great questions before our minds was whether central stations were economical. It was obviously far more convenient for the public to be supplied from a general source than for each one to generate his own electricity; in fact, the latter plan would be impossible, except in the case of large establishments. It was further obvious that the cost of both labour and coals in small plants would be far

* Cantor Lectures delivered before the Society of Arts.

greater than in a central station. But the fact remained that, with central stations, we had all the additional cost of mains run through the streets, involving enormous cost, not only in copper, but also in taking up streets, finding a way among all the underground pipes, and making all good again. We had just learnt, from the experience of the telephones, that the more subscribers there were after a certain limit, extending to greater distances, the less dividends could be paid. Consequently there were many men at that date who did not think that central stations could compete against isolated plants for even moderate sized establishments, and who saw no prospect of small consumers being supplied, except by neighbours clubbing together to generate electricity for themselves.

Fortunately the verdict has hitherto generally been that current can be economically generated in, and distributed from, central stations, and the proof is in the enormous ramification of electric circuits now occupying the beds of the streets of London. I do not know the case of any town in the world where such enormous progress—designed for permanency—has been made in so short a time. From 1882 to 1889 the legislative enactments restrained and held, as in a leash, the spirit of the age—which is electrical. In the last-named year, Major Marindin, acting for the Board of Trade, held the great inquiry in London, besides minor ones in other towns, as to what powers were to be granted to what companies. From the moment that his reports were accepted, the forces which had so long been restrained burst forth, and the pioneers, like released greyhounds, darted after their prey, and the whole place was in the hands of the electricians. All the work was well done, and will remain; and we may well be proud of what has been accomplished.

But while thus congratulating ourselves, we must not overlook the fact that we are prevented by several causes from supplying electricity so cheaply as might be hoped. I have already given you the figures with respect to one large club, and I could give you many others to show that at present, for a large establishment using light for long hours, an isolated plant is the cheaper. It is particularly to be remarked that the average number of hours that a light is in use is barely two hours a day. Hence, during the greater part of the twenty-four hours, the mains in the street are lying practically idle, the boilers and engines are earning no dividend, while the managing staff would have no more work if all the customers used the light for longer hours. Hence, during the greater part of the day, the cost of producing an additional electric Board of Trade unit is little more than the cost of the coal, certainly not 2d. a unit, while for a few hours in the evening it is at least three times as much. You see, then, how hard a fixed price per unit is on clubs and other places where a steady large supply is wanted for long hours. This is one reason why the public supply to the Athenæum Club would cost £500 more than the cost of making it on the premises. This is why the cost of an electric arc lamp for street lighting would be double what it would if not obtained from a supply company. If we had any means of supplying electricity for a short time as cheaply as at the full output all the 24 hours, we should reduce the selling price to one-third of what it is now.

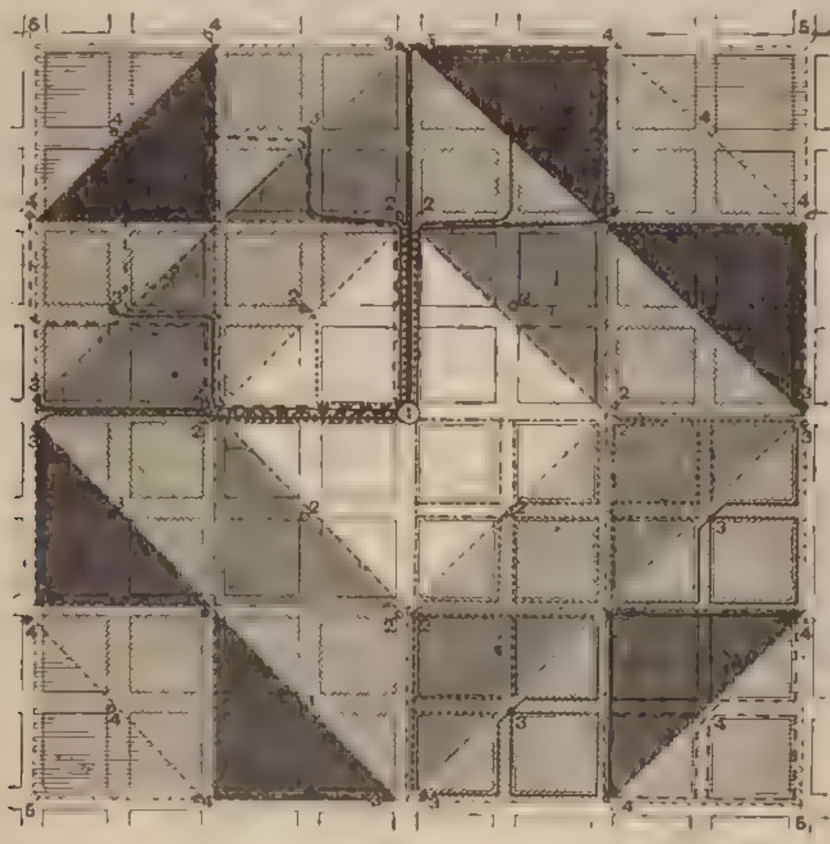

FIG. 1

ELECTRICITY *v.* GAS.

At the present time electricity in towns often costs twice as much as gas, and it is not everyone who can see that the gains counter balance the extra expense. It certainly saves expense in decoration, it is far more healthy, and in valuable buildings like the British Museum, it alone can be permitted as giving absolute immunity from fire where properly carried out. The same remark applies to all private houses. When a curtain or a dress is blown by the wind or otherwise brought into contact with a gas jet we have a fire. When this happens with an incandescent lamp we have absolute immunity. But by taking advantage of the facility of putting out a light in a bedroom when done with, great economies can be effected in careful households. There is one case in which electricity beats gas and other illuminants, not only in cleanliness, health, and security from fire, but also in economy, and that is in country houses. I could bear this out by numerous examples. One large old castle in Scotland, where the risk of fire was great, and the electric light was introduced primarily for security from fire, offers a good example. Here there are 210 lights of 16 c.p. installed, the house has always been full, and the lights much used. The installation cost £1,800, and last year, the second of working, an accurate note of all the expenses, labour, coal, etc., comes to £75. Nothing approaching to this could have been got from gas manufactured on the premises, and, at the rates charged by supply companies, the cost would have been over £300.

Feeders and Distributing Mains.

The satisfactory working of a central station depends largely on the proportion that the feeders bear to the distributing mains. Some stations have been started by persons quite incompetent to do the work, and have no feeders at all. The consequence is that we have enormous variations in the pressure at different times. I believe that at Brighton there is at times of maximum working a difference of pressure in lamps on different parts of the circuit amounting to 25 volts, and instead of applying the well-known engineering methods, it has been attempted to patch it up by putting lamps of different voltage on different parts of the system. When such a thing is attempted, except for the correction of a very few volts, we are landed in worse trouble. I would draw attention to the diagram on the wall, Fig. 1, representing the plan of an American city like Philadelphia, and showing the way in which the feeders and distributing mains would be run for lighting the city with economy, and confining the variation of pressure all over it within the same limits. The centre square, shown white, would have no feeders, but be divided up into four triangular-shaped districts, each being supplied by mains from the central station. The part between the feeding points marked 2 and those marked 3, would be divided up in the same way into triangular shaped districts, and each have its own feeder, and distributing mains starting from a No. 2 feeding centre; and so on for the districts outside these. It will be noticed that all the distributing mains starting from the feeding points are of equal length, if measured along the streets, as shown at the bottom right-hand corner of the diagram. The circuits being run in this way, a network may be formed by connecting the ends of the distributing mains together wherever close, and whichever district they belong to, since the pressure at these points will always be nearly the same—assuming the same current density in all the distributing mains, of course. I sent out a circular lately to try to find out how far the benefit of feeders was appreciated in our central station engineering, but very few supply companies cared to give the information. I find that the Kensington and Knightsbridge Company have:

	tons	cwt.	qrs	lb.
Total weight of mains	153	11	3	5
Total weight of feeders	15	10	3	0

in a total length of street covered = 12 miles 835 yards, partly copper strip, insulated by glass insulators, supported by oak bars, being used; and partly vulcanised rubber cables run in iron gas pipes coated with Angus Smith's composition.

The cost for straightforward work under foot pavement, including material, wages, superintendence, digging, and carting away, but not tools and spare plant, is stated to be:

	Per yard £	s.	d.
Five pipes, four of 2in., and one of 1½in., with three cables $^{19}/_{15}$, and two cables $^{7}/_{11}$	3	2	2
Three pipes, two of 2in., and one of 1½in., and three $^{19}/_{15}$ cables	1	8	6½
15in. culvert, including three strips 1in. × ⅛in.	1	3	9
20in. " " five " " "	1	9	0
24in. " " seven " "	1	14	2

The number of lamps supplied up to January 6, 1892, is equivalent to 38,680 of 8 c.p. The h.-p. available is—

Kensington court	1,070
Chapel place	700
	1,770

The total capital invested in mains of all kinds, including copper and cable, is 33 per cent. of £133,000, the total paid-up capital; in machinery and buildings 43 per cent., and in batteries 10 per cent.

At Chelmsford, with alternating currents, overhead wire is generally used, ¾ ton for street lights, 1½ ton for secondary wires, and one ton for primaries for private lighting. Indicated horse-power in station, 300; total outlay, £14,000. Lamps, 220 of 32 c.p., 1,000 of 8 c.p. for private use, 19 arcs of 10 amperes, and lamps in works using 180 amperes and 110 volts. Welsh coal per unit generated 8·8lb.; efficiency of an engine and dynamo, 75 per cent. (mean).

The Westminster Electric Supply Corporation's distributing mains are estimated roughly at two to two and a half times the weight of the feeders. The total capital of this Corporation is £300,000, the total indicated horse-power in central stations 3,500, and the number of lamps supplied equivalent to 66,000 8 c.p. The cost of mains and underground work is roughly £150,000, and the total length of pavement opened up is 53,640 yards. In places, the mains consist of bare copper in concrete culverts; but the Corporation have by far a greater length of insulated cable laid in Callender casings.

(To be continued.)

HASTINGS.

The town authorities have, as they ought to have done, determined to light the sea front by means of the electric light. The determination was not made without a struggle, as will be seen from the report of the meeting:

The Public Lighting Committee had to report that they had under consideration the matter of the desirability of extending the electric light on the Front line. They had been in communication with the Hastings and St. Leonards-on-Sea Electric Light Company, Limited, on the subject, and had ascertained that the company were prepared to enter into a contract with the Corporation for the lighting of the Front from the Fish Market to the end of West Marina, for a period of three years, by means of 32 arc lamps, placed about 50 yards apart (instead of 100 yards, the distance between existing electric lamps), the whole of the lamps to be lighted from sunset to 12 midnight, and after that hour each alternate lamp to be extinguished, and the other lamps to be kept alight till sunrise, the company undertaking to maintain a steady light, free from extinctions, at £25 per lamp per annum, the contract to commence as soon as the company had made the necessary additions to their machinery (which, the committee were informed, would be of the latest and most improved type, and duplicated to prevent any failure in the supply) and extended the mains, etc. The committee had fully discussed the company's offer, and had received from the borough surveyor a report prepared by him, in accordance with their instructions, for their guidance and information on the subject, and under all the circumstances recommended that such offer as above set forth be accepted, and that the town clerk be authorised to affix the common seal, in due course, to the necessary formal contract with the company.

Councillor Duke moved the adoption of the report. He detailed all the propositions as contained in the report, and dilated upon the necessity of having either gas or electric light instead of both, as at present. The present cost per electric lamp was £30 per annum, which meant a total expense of £450 per annum for the whole; whilst the proposal, if carried out, would secure each lamp at £25 per annum. The space between the Fish Market and West Marina was at present lighted by 15 electric lamps, 69 Whitehalls, and 43 ordinary single burners, and the total cost was £1,038. The new electric lamps would have no arms that would throw a shadow, as did the present ones. Comparing the proposed electric lighting with that used at present, there would be a great advantage in candle-power. To light the Front with Whitehall lamps, placed 40 yards apart, 98 would be required, at a cost of £1,046 12s. 4d. per annum, whilst the proposed system would cost £1,300, or about £250 more than the other. They were all sensible of the excellence of the Whitehall lamps, but he felt that the ratepayers and the public generally would not be best pleased by the electric light being done away with. With regard to the question of the Corporation having its own light works, it was proved that they could not supply light so cheaply as they could get it from the electric light company.

Councillor Elworthy seconded, and said that there was one thing certain, and that was they could not take a retrograde step, as the electric light was the illuminant of the future. It was acknowledged by all hands that the present lighting was bad; anything more miserable they could not conceive. At the present time the electric light was put out at 11 o'clock, and then the gas was reduced to half its power, which put him in mind of the miserable condition of affairs they experienced in that part of London in which he lived when a boy, and when the oil lamps were used. What they had to consider was the difference of the power of the two lights. He had made a calculation of the difference of the power, and he found that the maximum electric light would give a light six times as great as the gas, and the difference in the mean light was four times as great. When they took into consideration that after 12 o'clock only half of the lamps would be lighted, that would mean having six times as much light as they got at present from the gas. The company had agreed to put down a separate main for the lamps and had guaranteed, when the new machinery was erected, to give a continuous steady light. The lamps would be 50 yards apart, and he had made a test and had come to the conclusion that there would be no dark space between the two lamps. He thought the alteration would be a great improvement to the town, and hoped that the resolution would be carried.

Councillor Ellis said up to noon of the previous day he favoured the alteration, but then he was given certain information which

had put a different complexion upon the case. In the matter he was a layman, and had to be guided by the advice of men who were qualified to give definite information upon the point. He had a great respect for the opinion of their surveyor, who was an engineer, but another gentleman he had met, whom he equally respected as an engineer, formed quite a different opinion to that of Mr. Palmer. The two gentlemen greatly differed as to the illumination they would receive from the electric light, and before any decision was arrived at he thought it would be better that an independent engineer should be asked to make a thorough test, and report to the Council.

Mr. Palmer remarked that the gentleman who had given information to Councillor Ellis was an interested party.

Councillor Ellis said he had as much confidence in one gentleman as the other, but he did not wish to take a leap in the dark.

Alderman Jenner, Councillors Stanger and Wright, Aldermen Bray and Bradnam, Councillors Shoesmith, Eaton, Tuppenney, and Duke all joined the discussion. Ultimately the resolution was put to the meeting, and the following voted in favour of it: Councillors Duke, Tuppenney, Wright, Pigott, Chapman, Shoesmith, Eaton, Sutter, and Elworthy. Those who voted against it were: The Mayor, Aldermen Jenner and Bradnam, Councillors Hutchings and Stanger. Councillor Ellis did not vote. Alderman Bray, Councillors Stubbs, Weston, Slade, and Ellis, being shareholders in one or other of the companies, could not vote.

LEGAL INTELLIGENCE.

THE ST. BENET FINK AND ST. NICHOLAS COLE ABBEY FACULTIES.

Transformer Chambers for the Electric Light.

At a sitting of the Consistory Court of London, held on the 3rd inst. in St. Paul's Cathedral, before Dr. Tristram, Q.C., Chancellor of the Diocese of London, who was attended by Mr. E. W. Lee, the registrar, the **Chancellor of London** delivered judgment in these cases, as follows: On Monday last, the 29th ult., application was made to this Court to authorise by faculty the construction of transformer chambers or vaults in two City churchyards long disused for burials—one in the churchyard of St. Benet Fink, close to the Royal Exchange, and the other in the churchyard of St. Nicholas Cole Abbey, in Queen Victoria-street—for the use of the City of London Electric Lighting Company, Limited, to enable the company to introduce the electric lighting into those parts of the City in which the churchyards are situated. The construction of these chambers will involve the disturbance of human remains and their removal and reinterment in some other consecrated burial ground. The petitioners for the faculty for the construction of a chamber in the churchyard of St. Benet Fink are the Mayor and Corporation of London and the rector and churchwardens of the parish, and the petitioners in the case of St. Nicholas Cole Abbey are the rector and churchwardens of the parish. Each of the applications is supported by resolutions of the vestries of the respective parishes passed unanimously. Certain of the facts adduced by the petitioners in support of the granting a faculty are common to both applications. It appears that the City of London Electric Lighting Company was established by Act of Parliament with the object of lighting the streets, offices, and houses in the City with electric lights, with a nominal capital of £800,000. The company, in furtherance of this object, has during the last 12 months expended £350,000, and has contracted with the Corporation of London to light the streets of the City for an annual payment of £20,000 on the completion of the system. The church and site and the churchyard of St. Benet Fink were by a local Act of Parliament, 5 and 6 Vic., cap. 101, vested in the Mayor and Corporation of London, with a view to extend the avenues adjoining to the Royal Exchange, and a portion of the site was appropriated under the Act for that purpose. The Act provides that as soon as the "said church and burial ground shall be cleared for the purposes of the Act, the mayor, aldermen, and commons in common council assembled shall cause the same, except such part thereof as shall be laid into the streets or public ways or appropriated for parsonage houses, as in the Act mentioned, to be enclosed by a substantial iron railing or other substantial fence, and the residue of the said site and burial ground shall remain for ever unbuilt upon and unappropriated to any purpose except such ornamental purpose as the said mayor, aldermen, and commons in common council assembled, with the consent of the Bishop of London for the time being, signified by writing under his hand, shall think fit to direct." By this section the Court is precluded from dealing with the site of the churchyard, and by the Act the Corporation have now no power to deal with the vaults underneath the site, and the vaults being in consecrated ground this Court has jurisdiction to make such orders in relation to them as the circumstances of the case may require. The question is whether it has under the circumstances of this and the next case discretionary power to make the orders asked for. In support of this application, the following facts appeared in evidence: By the construction of the chamber the company will be enabled to light an area comprising Cornhill, part of Bishopsgate-street Within, Threadneedle-street, part of Old Broad-street, Throgmorton-street, and the lesser thoroughfares leading between these streets. For the purpose of lighting this area 7,000 incandescent lights have already been applied for, including 1,200 lamps by the Bank of England. To light this area it is necessary that the company should have a transformer chamber within 50 yards, at least, of St. Benet Fink churchyard. The Commissioners of Sewers have granted permission for the erection of these chambers in narrow thoroughfares, but have refused permission in the present case, as its construction would disarrange the telephone and telegraph and gas and water companies' pipes; and owing to the site required being a crowded thoroughfare, it would be for other reasons objectionable. The company has also approached owners of adjoining property with a view to arrange for a sale of the site required without success. They have no compulsory powers to compel a sale of land for the purpose under their Act; and in the result, if this application were to fail, the area in question will remain unlighted by electric light. The petitioners have thus made out a strong case of urgency in the interests of the parishioners and public in favour of their application. It also appears that several applications have been made to the company to light the City churches for Sunday evening services, which are well attended, and it is therefore against the interests of the Church that the scheme should fail. The company also offer the payment of £25 to be appropriated towards the church expenses of the parish church. The special facts in support of the application in the case of St. Nicholas Cole Abbey are as follows: The church and churchyard abut on Queen Victoria-street. Part of the churchyard was many years ago appropriated, under an Act of Parliament, for the construction of the District Railway. The chamber required cannot be constructed under the streets owing to there being a subway for the supply pipes of the water and gas companies, and the company have failed to acquire a site by private purchase. The proposed chamber will supply from 20,000 to 25,000 incandescent lamps, and there have already been applications for 5,000 lamps. The church is lighted with electric light, and the company offer an annual payment of £30 towards the church services. If the faculty is refused the electric lighting of the church will cease. The area to be lighted from this chamber will be the whole of Queen Victoria-street as far east as Cannon street, a great portion of Upper Thames street, Knightrider street, and the lesser intervening thoroughfares. The refusal to grant the faculties asked for will deprive the streets and houses and offices in the areas mentioned of the advantage of being lighted by electric light, and the question before the Court is whether it has a discretionary jurisdiction in the matter, and if it has whether it would be proper exercise of it to grant the faculties prayed. It has already granted two faculties to this company, giving it the use for 21 years of portions of two churchyards in the City for the construction of an entrance and subway to transformer chambers, constructed by permission of the Commissioners of Sewers under narrow streets. This case does not come within the class of cases referred to in "The Queen against Twiss" (L.R. 4, Q.B. Cases, 407). The rule applicable to this and kindred cases is thus laid down by Sir John Nicholl: "Faculties are to be granted at the discretion of the Ordinary, but it must be a sound discretion, having a due regard to times and circumstances, and to the rights and interests of all parties concerned; if an unsound discretion be exercised a party may appeal to a superior tribunal" ("Butt v. Jones," 2 Hagg's Eccl. Reps., 424). The Court is of opinion that it would not be exceeding its jurisdiction in granting the faculties prayed, and that under the exceptional circumstances of these two cases it will be exercising a sound discretion in granting them. It therefore decrees the faculties as prayed—the faculties not to issue within 15 days, and advertisements to be inserted in the *Times* and *City Press*. So as to enable any members of families buried in the vaults to make application to me in chambers relating to their removal, a proviso will be inserted in the faculty permitting the removal of remains if desired, by members of the families to any consecrated burial ground selected by them. The other remains will be removed to the parochial burial grounds of the respective parishes for reinterment in the consecrated portion of the cemetery.

Mr. Arnold Statham appeared for the petitioners.

COMPANIES' MEETINGS.

CITY OF LONDON ELECTRIC LIGHTING COMPANY.

The second annual general meeting of this Company was held at Winchester House, Old Broad street, E.C., on Thursday, the 1st inst., Sir David Salomons, Bart., chairman of the Company, presiding.

The **Chairman** said that on the last occasion he had the honour of appearing before them it was with considerable difficulty that they succeeded in getting the one shareholder to attend who constituted their audience. It was gratifying, therefore, to find there was a good attendance of shareholders. It showed that, if before they had complete confidence in their Board to carry out the affairs of the Company, their interest had been awakened; but he trusted that their confidence was not lessened in consequence. Before moving the adoption of the report he proposed giving them a full account of the work they had done since the last time he addressed them. Application was made for shares amounting to £300,000, which they considered very good, having regard to the fact that the times were bad. At the period he spoke of £100,000 worth of shares remained to be applied for, but the amount had since been taken up, he was glad to say, and the money would be employed at their works in a very short time. It was therefore the intention of the Board to

issue preference stock to the amount of £200,000 at 6 per cent., and to give the shareholders the first chance of obtaining it. That 6 per cent. was very well secured, and it might be regarded as a first class property when in their hands. Before very long—he did not mean in a month, or even six months, but perhaps in 12 months—he did not want to be too hopeful—they would be able to pay a dividend to the ordinary shareholders. Matters were now beginning to mend. The first difficulties which had to be encountered had been met, and their affairs were beginning to take a turn. Their stations were working at a small profit, which would grow as the machinery came more and more into work. They were not working at full load, but as time went on the profits would increase. At the present time their sites and buildings and other works—in fact, a great many matters which he would not trouble them with, but which must exist—brought in no return. That was a necessity with undertakings of that nature. All the money they were now expending would be fruitful. There were one or two points in the report he would like to call attention to. They stated that "from calculations based on the lamps already connected to the Company's mains, it appeared that the consumption of current per lamp installed in City offices, shops, etc., would be much greater than was anticipated." It had been pointed out to him that that might be taken to mean that the consumers of electric energy in the City were in some way at a disadvantage. But that was not so. In the West-end, where there were drawing rooms and occasional parties and shops which were only lighted for a short period, the number of lamps installed was four times more than those in general use. In the City all the lamps would be in use when the weather was dark, and consequently the return would be far greater. It did not mean that the customers in the City would be at a disadvantage, but that the circumstances were favourable to the Company. Sir David then dwelt on the importance of not stinting money in putting up the fittings. Nothing had brought a bad name to electric lighting in the City so much as cheap fittings. With water, gas, and sanitation they were most particular. Why should they not be so with the electric light? The whole of the evil was generally attributable to the lowest tender for the work being accepted, instead of taking the offer of the firm that would execute the requirements in the most satisfactory manner. All the work executed by the Company in erecting their fittings was extremely well done. There was no bad work of any kind anywhere. They wanted to make the concern an example to London and all the other great cities of the world. There would be no hurry, and the Company were not going to allow a bad name to be brought on to the City. No trouble was being spared by the Board, who gave every attention to the details in connection with the affair. They had the experience of other companies of a similar nature, and the shareholders were having the benefit of that knowledge. There was only one matter for regret he had to mention. One of the directors, the Hon. Alan Charteris, who had taken a most intelligent interest in all they had been doing, became suddenly ill, and he had been away for some time. It was gratifying to know that he had returned from abroad very much better, and they all hoped very soon to find him at the Board meetings once more. In the accounts the sum of £1,500 appeared as being due for calls, but that had nearly all been paid since the balance sheet was printed. The accounts as printed did not convey very much information, but that could not be helped during the progress of the work. They hoped to send the shareholders a much fuller statement presently. In the West end there would be a considerable amount of current used between the hours of 4 p.m. and 9 p.m., but at other times the demand would be small. The light in the City would be very different. The amount of current required would be far more constant, and this, of course, was a very good thing for the shareholders, because they would be making a great deal more out of the machinery, which they would be bound to keep running. What they were longing for was a good London fog. They had some experience last week of a dark day in London, which frightened them a little, but the trouble would never occur again. They wanted some good fogs—favourable dark days—and then they would be able to discover what the City population really required of them. The Board had always endeavoured to supply the current as cheap as possible, and if they were able to reduce it they would be glad to give the consumer the benefit of it. He could not speak too highly of the work done by their officers, who had been pushing matters forward as much as possible consistent with reason. A little patience would have to be exercised on the part of the public, and in a few months they would be able to give entire satisfaction to the citizens. They had laid under the ground much more plant than would be required, but in spite of that fact his private opinion was that the demand for the light would grow so rapidly that they would have to have the City up again and lay more mains. But that would not happen for five years. The crane, pumps, and other machinery at the stations were to be worked by electric motive power because it was convenient and cheap, and the public would then be able to see that the system was an economical one. They hoped that railway stations and other public places would soon be lighted by their light when the Board of Trade regulations were less severe. By the spring of next year it was expected that their stations would be able to supply 78,000 8 c.p. incandescent lamps, in addition to the 700 lamps in use now. Their gross earnings were now £20,000, and every increase of light meant a considerable measure of profit. In order that they should not be taken unawares when the dark days came, they intended making an experiment. They proposed to take observations from high places to see if fogs were coming. The Docks Committee had kindly promised to telegraph any information of fogs coming up the river, and other bodies would communicate with them as far as possible. If they only had 10 minutes' notice of the coming of the fog they would be all right; and if the fog came from above without any intimation—well, then they would give it their best attention while it was here. As regarded street work, as much as 30 miles of tubing had been placed underground in a week, but the average was 10 miles a week. The contracts with the Corporation for arc lighting the main thoroughfares would be complete in two or three weeks. In addition to that they had put up many lights which were not compulsory. Their last day for completion was November 5, but they had finished two months before the stipulated period. The shareholders would, he thought, agree with him that they had in no way been asleep. He then moved the adoption of the report and balance sheet.

Mr. A. Pursell, C.C., seconded the proposition, which was agreed to without discussion.

Messrs. W. H. Pannell and Co. were re-elected auditors of the Company at the remuneration of 100 guineas.

Mr. Copland proposed a vote of confidence in the Board, remarking that the shareholders were very much indebted to them.

Mr. E. M. Smart seconded, and the resolution was adopted *nem. con.*

The **Chairman** thanked the shareholders for the compliment, and hoped the result of the Directors' work next year would be satisfactory to the proprietors.

The proceedings then terminated.

BUSINESS NOTES.

Chertsey.—Advertisements are to be issued for offers to light the district electrically.

Great Northern Telegraph Company.—The receipts for the month of August were £23,600.

Railway Stores.—Messrs. Angus and Co., of Liverpool, are inviting tenders for 20 tons of galvanised telegraph wire.

West India and Panama Telegraph Company.—The receipts for the half month ended August 31 were £1,930, against £2,428.

Bristol.—Sanction has been given by the Local Government Board for the borrowing of £66,000 for electrically lighting the town.

Eastern Telegraph Company.—The receipts for the month of August were £49,069, as against £53,398 for the corresponding period.

Cuba Submarine Telegraph Company, Limited.—The receipts for the month of August were £11 less than for the corresponding period.

Loughborough.—Plans for the extension of factory and stores for the Brush Electrical Engineering Company have been approved by the Town Council.

Derby.—Tenders are invited for electric lighting machinery and accessories at the central station. Full particulars will be found in our advertisement columns.

Dolgelly.—The Dolgelly Local Board have decided to light the town with electricity. Mr. Hall, of Liverpool, has contracted to light the town during the winter.

Pitlochry.—Messrs. A. and J. Macnaughton, manufacturers, have just completed the successful installation of electric light in their Pitlochry tweed mills and warehouses.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,166.

Hertford.—Enquiries as to the question of the electric lighting of Hertford are being made, and the local authorities have issued a pamphlet upon the subject detailing the advantages.

Northern Electric Wire Company.—The Northern Electric Wire and Cable Manufacturing Company, Limited, Halifax, have again declared their interim dividend at the usual rate of 7½ per cent. per annum.

Dublin.—Application has been made by the municipal authorities for a loan of between £1,500 and £1,900 for the supply of electric light fittings to the Corporation offices and the fire brigade stations.

Blackburn.—A deputation from the Town Council has been in consultation with the Local Board to consider the question of the purchase by the Corporation of certain land belonging to the Board for the purpose of erecting an electric lighting station.

Barnet.—Some members of the Barnet Local Board have been engaged in obtaining further information about electric lighting, and a special committee will, we understand, report to the Local Board recommending an application for a provisional order.

Conservative Club.—The contract for the wiring of the Conservative Club, St. James's-street, which work, as mentioned last week, is being carried out under the superintendence of Mr. A. A. C. Swinton, has been placed with Messrs. Hancock and Rixon.

Glasgow.—The Corporation Tramways Committee invite persons desirous of submitting estimates to equip certain of their tramway routes for working on the overhead wire system, to communicate with their general manager, Mr. John Young, City Chambers, Glasgow.

City and South London Railway Company.—The receipts for the week ending September 4 were £737, against £672 for the same period of last year, or an increase of £65. The total receipts for 1892 show a total increase of £621 over those for the corresponding period of 1891.

Sunbeam Lamp Company.—This Company notify that although they have temporarily ceased the manufacture of the Sunbeam lamp, they are still supplying their patent Sunbeam holder, and the Edison Swan Company, to meet the demand, are making lamps to suit these holders.

Light and Power at Tornavento.—The water company intends to erect a light and power station for the distribution of energy in the districts of Busto, Legano, Gallarata, and Milan. It is intended to erect a plant sufficient to distribute 25,000 h.p., about half of which is required for the district of Milan.

Hanley.—We understand that the tender of the Brush Company, amounting to £15,760, has been accepted for the electric lighting at Hanley, and sanction is to be obtained for the borrowing of £15,760 for this purpose and also for £5,240 for buildings, etc., the amount so borrowed to be repaid within 60 years.

Telephony.—It has been resolved to connect Glasgow and Belfast *vid* Stranraer. Operations have been commenced simultaneously at Glasgow and Stranraer with the formation of a trunk wire and the cable will be laid in the spring. It is intended to tap the wire at several places between Glasgow and Stranraer.

Heckmondwike.—A meeting of the ratepayers was convened to consider the question of the proposed electric lighting of Heckmondwike, but owing to the inclemency of the weather and other causes the attendance was very small. It was suggested that the meeting should be postponed to another evening. The suggestion was adopted.

Chelmsford.—The report of the Lighting Committee to the Council gave an account of an interview had with a representative of Messrs. Crompton and Co., Limited, as to the irregularity in the electric lighting of the town. Messrs. Crompton and Co. wrote hoping that the new arc lamps would be fixed in seven weeks' time. They were making every effort to get the work through.

Chatham.—Proposals, it is stated, are now being made that the Chatham Corporation should purchase the electric light undertaking, which is at present in the hands of a company. At Maidstone the provisional order has been retained by the Corporation, by whom the powers will probably be utilised. Canterbury and Dover, on the other hand, have practically come to terms with the Brush Company, and early installations may be expected in both towns.

Rome.—Those who rave about the antique are dissatisfied with the lighting of Rome by electricity. It is a great pity that some of these people could not be relegated into the mediæval times, or, better still, be compelled to live in some part of the earth where they could retain their peculiarities of civilised life of a thousand years ago. Why should a city like Rome be deprived of the advantages of light because a few thickheaded individuals like to see it as it was in the days of the Cæsars?

Bray.—The electric lighting of Bray will be finally completed in the course of a few days. The contractors, Messrs. J. E. H. Gordon and Co., 11, Pall-mall, London, have been running the plant for some time, but the Commissioners' contract will not commence until, as stipulated, the water power is supplemented by steam plant for times of extreme drought or frost. The engines are now almost complete, and Messrs. Gordon expect to commence running under contract by the end of this week or early next.

Companies of the Month.—The following electrical companies have been registered during the past month:

Colner Marr Telephone and Electrical Manufacturing Company, Limited, £10 shares	£100,000
Hove Electric Lighting Company, Limited, £5 shares	40,000
Kennedy Storage Battery Company, Limited, £1 shares	100,000
United Electric Sewage and Chemical Syndicate, Limited, £1 shares	5,000

Derby.—The Town Council has bought several houses and a piece of land for the purpose of enlarging and improving the new electric lighting station when occasion requires. The Electric Lighting Committee have accepted the tender of Messrs. G. Fletcher and Co., Derby, for boilers and accessories at the electric light station, and the building and dynamo contracts are in preparation. The committee recommend the appointment of a resident electrical engineer to act as clerk of the works during their construction, and to manage them when completed.

Weybridge.—Three months since the authorities granted the promoters of the electric light at Weybridge an extension of three months in order that they might be able to raise capital and satisfy the requirements of the Board of Trade. This three months has expired, and the company has practically done little or nothing towards the matter. A meeting has been called in Weybridge, and a small committee appointed. If the necessary capital cannot be raised locally, a syndicate will probably take the matter up, so under the circumstances, the Authority has granted a further extension of three months.

Whitehaven.—At a meeting of the Electric Lighting Committee of the Whitehaven Town and Harbour Trustees, tenders for iron and steel work for foundations of engines and dynamos to be placed in the sewerage engine house for the purpose of electric lighting were considered, and it was recommended that the tender of Messrs. Ramsay Bros. being the lowest, be accepted by the Trustees. It was also recommended that the tender of Messrs. Galloway, Limited, of Manchester, for two boilers be accepted, and the tender of the International Okonite Company, Manchester, for conductors be also accepted. The acceptance of these tenders is subject to the sanction of the Local Government Board being obtained to the loan for electric lighting purposes, which has been applied for.

Burnley.—The Local Government Board has sanctioned the application made by the Council for permission to borrow £23,500 for the purposes of the electric lighting of the borough. The Electric Lighting Sub-Committee also accepted the following tenders in connection with the work required in the erection of the electric lighting station in Grimshaw street, on the site of the old Pillingfield Mill: T. Smith, Burnley, excavating, masonry, and bricklayers' work, £2,764 11s.; E. Wood, Manchester, ironwork, £423; R. Dean and Sons, Burnley, carpentering and joinering, £550; Owen and Co., Burnley, plumbing and glazing, £259; Whittaker and Schofield, Burnley, slating, £128; T. S. Ratcliffe, Burnley, plastering and painting, £103 7s. 8d. At a meeting of the Fire Brigade Sub-Committee the tender of Mr. John Barritt was accepted for the fitting up of a series of electric fire alarms from the central fire station to the houses of the firemen.

Llanelly.—In connection with the proposed lighting of certain streets in the town by electric light, the Local Board, at Monday's meeting, considered a report of the committee of the whole Board upon the subject of the offer of the British Electric Installation Company, Limited, to take over the provisional order and cost of the same, the Board to have power to purchase the undertaking at any time within 42 years, either by capitalising the net profits or paying the actual capital expended, as shown by the books of the company, the purchase money to be paid in bonds or stock of the Board, bearing interest at 5 per cent., redeemable at par at the end of 21 years. In the event of the company having a dividend of 10 per cent. upon the capital, the price charged to consumers of electricity to be reduced a ½d. per unit for every complete 10 per cent. paid over and above 10 per cent. Clause 52 of the order to be excepted from the transfer, the Board also to have the power to excavate the trenches for laying the mains, the company paying the cost thereof.

Hayle.—On Saturday evening last the electric light was inaugurated for the first time in Copperhouse on the premises occupied by Messrs. J. and F. Pool, metal perforators and ironmongers. The contract for the installation was secured by Mr. F. M. Newton, of Taunton, and the work has been most successfully carried out by his representative, Mr. Edgar Pool. The light was switched on by Miss W. Pool, the whole of the establishment being immediately illuminated, the contrast between the old and new light being very marked. The motive power used for driving the Taunton dynamo is supplied by the engine which drives the perforating machinery. The dynamo is capable of supplying 36 16-c.p. lamps, all of which can be controlled from the engine room by means of a switchboard, upon which are also the instruments to indicate the voltage and the number of amperes generated. Each lamp has also a separate switch, so that any number can be turned off at pleasure. During the evening an electric search light was displayed from the rear of the premises by Mr. Pool.

Australia.—The Rockhampton Gas and Coke Company's report just to hand says: "Since the last meeting the work of installing the electric light has been proceeded with. The bulk of the plant has already arrived, and is in course of erection. Special care has been exercised in procuring the best and most improved description of dynamos, engines, boilers, and other important machinery, and the directors are assured by the electrical engineer, upon whom they have to depend for advice in all matters appertaining to the installation, that the light will be satisfactory and reliable in every respect. It is expected that the electric current will be in operation by the end of August. The general offices and showroom are now located in the new buildings in Alma street, and have already been of great service to the company's constituents. As you are aware, debentures to the value of £10,000 were issued about two years ago in anticipation of the capital required for the electric light installation. It was afterwards considered advisable to devote part of this for the erection of a new gasholder, which reduced the amount by over £2,000; other enlargements in the gas plant, notably the extension of the mains to North Rockhampton and the hospital, have also encroached on the amount originally in hand, and it will, therefore, be necessary to issue more debentures or shares to keep pace with the further developments that will take place with both the gas and electric light. All the projected extensions promise a very good return upon the capital involved."

Aberdeen.—The Town Council of Aberdeen at their last meeting discussed the recommendation of the Gas Committee that the Corporation should proceed with the lighting of the eastern district of the city at an estimated expense of £24,000. Prof. Kennedy, London, who had been consulted, reported that the compulsory area should include Castle street, Union street, as far west as Bon Accord street, Market street, Broad street, St. Nicholas street, the southernmost block of George street, Schoolhill, and the circuit round the new road by the Free Library, and down Union terrace. About 10,000 lamps of 8 c.p. would be installed, of which about 7,000 would be in the eastern and 3,000 in the western district. The central station will be located in Cotton street. If 8d. per unit were charged at starting (this being 1d. below the maximum), Prof. Kennedy considered that the Council might fairly hope to earn an income at the rate of at least 9s. per annum per lamp installed, or £4,500 by the time they had the equivalent of 10,000 lamps on circuit. Mr. Bisset moved, and Mr. Johnston seconded, that the scheme be proceeded

with. Bailie Nicol moved as an amendment that steps should first be taken for the purpose of ascertaining the probable number of consumers in the district proposed to be lighted, and this was seconded by Mr. Farquharson. On a division it was resolved by twenty-four to five to proceed with the lighting of the eastern district as indicated in the report, and it was remitted to the Gas Committee to have the scheme carried into effect.

Morecambe. – A deputation from the Tradesmen's Association from Fleetwood went the other day to inspect the electric light at Morecambe. Messrs. S. Fletcher and J. Smyth. Mr. Richard Edmonson, of London, of Fleetwood pier fame, was also on board, as well as Messrs. T. Clark, R. Carter, and Lowthwaite, who accompanied the representatives of the Tradesmen's Association to the central lighting station, where they were shown round by Mr. Collinson, the superintendent. They learned that there was plant at Morecambe equal to 1,000 lamps (8 c.p.). The cost of the plant was £4,500, and they have more applications for the light than they can supply, at least until they increase their power. Upon making further enquiries they gleaned from Mr. Cutts, chemist, who had nine 8 c.p. lamps in his establishment, that the electric light cost him £4. 10s. per annum, and his gas bill previously ran from £10 to £12 per year. At the next shop, the proprietor also said the electric light was undoubtedly cheaper than gas, and advised them by all means to urge its adoption at Fleetwood. Mr. Birkett, chemist, said he had eight 8 c.p. lamps, for which he paid £3. 12s. per annum. He had contracted for the light for three years, and thereby got a reduction. He was also allowed 5 per cent. off the above price. With the same number of gas lights his bill was from £4 to £5 per year. At the central station the deputation also inspected the accumulators, which are used for storing during the day the power required at night. The effect is to keep up a steady current. The supply cannot be shut off in a moment, and if the engine stops the accumulation is there. We believe a very favourable report will be presented to the Tradesmen's Association regarding the electric light.

Cork. – The Cork Gas Consumers' Company has given notice to the Corporation that it intends to apply for a provisional order to supply electric energy within the municipal borough. At the last meeting of the Corporation a deputation from the gas company, consisting of Mr. Geo. Lynch (chairman), and Mr. Denny Lane (secretary), attended the meeting in support of the application. Mr. Lynch pointed out that although not absolutely necessary to obtain the consent of the Corporation, it would facilitate matters by so doing, and the gas company being entirely composed of fellow citizens, they had no wish to have any contention with the Corporation. If the Council thought the time had come when the city should have the advantage of the electric light, the gas company could certainly supply it on better terms, and on more advantageous terms, than any electric light company, who would have to depend for profit solely upon the electric light. They could supply the Corporation on better terms. Some persons had got the idea that if the gas company got the electric lighting into their hands they would starve it for the benefit of the gas business: he promised that this would not be so. The gas company had no power at present to apply any portion of their funds for electric lighting. If the electric light was introduced, the city would be better lighted than it was at present. Mr. Lynch pointed out that it was not well lighted now, owing to the class of burners the Corporation had placed on the lamps. Of course, the expenditure would be increased. Mr. Lane, after some conversation between the chairman of the Corporation and others, pointed out that the gas company would be in a position to supply at a much cheaper rate than any other company, and described in detail the manner in which the light would be supplied throughout the city for household and municipal consumption. He thought the electric light could be supplied in the first instance at 8d. per unit, and the price diminished as the consumption increased. An amendment to the acceptance of the gas company's proposition was made by Mr. Julian, who wanted the matter sent back to the Electric Lighting Committee to be considered with the increased information now before them. Sir John Harley Scott seconded this amendment, and when put to the vote the result was an equality of votes for and against. The chairman would not give a casting vote, so that the amendment fell through. Mr. Alderman Dale proposed as a further amendment that the consideration of the gas company's application should be postponed until they had a report from the committee, and this suggestion was adopted.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3¼
— Pref.	—	2¼
City of London	—	10¼
India Rubber, Gutta Percha & Telegraph Co.	10	20¼
House to House	5	5⅜
Metropolitan Electric Supply	—	7
London Electric Supply	5	⅞
Swan United	3¾	3¼
St. James'	—	8
National Telephone	5	4⅛
Electric Construction	10	5
Westminster Electric	—	6
Liverpool Electric Supply	5	6¼
	3	3¼

PROVISIONAL PATENTS, 1892.

AUGUST 29.

15469. **Improvements in signalling apparatus for telephones.** Georg Eduard Heyl, 4, Little Moorfields, London. (Complete specification.)

15477. **Improvements in the means for and method of melting metals and other materials by electricity.** August Friedrich Wilhelm Kreinsen, 70, Market-street, Manchester. (Complete specification.)

15492. **Improvements relating to the lubrication of parts of machinery with the aid of electricity.** Henry Harris Lake, 45, Southampton buildings, Chancery lane, London. (Johann Friedrich August Hoppe and Albert Jacobsen, Germany.)

15501. **Improvements in means for lighting oil lamps by electricity.** Joseph Domecq Cazaux, 4, South-street, Finsbury, London. (Complete specification.)

AUGUST 30.

15552. **Improvements in and relating to electric cigar-lighting lamps.** William Joseph Eastman, 77, Chancery lane, London. (Complete specification.)

15591. **Improvements in electric arc lamps.** Johann Christian Wüst, Norfolk House, Norfolk-street, Strand, London.

AUGUST 31.

15649. **Apparatus for continuous decomposition of alkaline chlorides by electrolytic fusion.** Jean Stoeck, 28, Southampton buildings, Chancery lane, London.

15650. **Electric apparatus for illuminating the sights of fire arms at night.** Giovanni Garassino di Giovanni, 28, Southampton buildings, Chancery-lane, London.

SEPTEMBER 1.

15665. **A method of eliminating the cross-magnetism in the armatures of continuous current dynamo electric generators and motors.** James Dick and William Scott, Greenhead, Glasgow.

15671. **Medicated electricity or special use and application of electricity for medical purposes.** David Balmford, 20, St. Andrew's place, Bradford.

15689. **Improvements in relays for electric telegraphs.** Cyprien Renelde Joseph Willot, 47, Lincoln's inn fields, London.

15690. **Improvements in overhead trolley for electric railways.** Benjamin Kochs and Albert Kochs, 52, Chancery lane, London. (Complete specification.)

15691. **Improvements in electric air ships.** Charles Drill, 52, Chancery-lane, London. (Complete specification.)

SEPTEMBER 2.

15767. **Improvements in gas outlet valves, or plugs for electric battery cells or other like vessels.** William Mosetop, 47, Lincoln's inn fields, London.

15790. **An electric lantern.** Henry Charles Gover, 28, Southampton buildings, Chancery lane, London.

15793. **Method of smelting or overheating iron or other metals by mean of electricity.** Carl Gustaf Patrik de Laval, 77, Chancery lane, London. (Date applied for under Patents Act, 1883, Sec. 103, March 8, 1892, being date of application in Sweden.)

15795. **An improved system of electrical distribution.** Sydney Ferris Walker, 45, Southampton buildings, Chancery lane, London.

15799. **An improvement in galvanic batteries.** Edward Nunan and John William Nelson, 160, Fleet street, London. (Complete specification.)

SEPTEMBER 3.

15813. **Improvements in the formation of junctions for electric mains.** Arthur Moor Thompson, Holly Bank, Crewe.

15833. **Improvements in telegraphic apparatus.** William Phillips Thompson, 6, Lord street, Liverpool. (Louis Dill, Germany.) (Complete specification.)

15840. **Improvements in electric arc lamps.** Rookes Evelyn Bell Crompton and Edmund Arthur Norman Pochin, 55, Chancery lane, London.

15864. **Improvements in electrical switches.** Claude William Atkinson, 1, Queen Victoria street, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1891.

11712. **Electric batteries.** Hall.

16250. **Dynamo machines.** Hammond and Hall.

16293. **Electrically propelling ships, etc.** Heys. (Heilmann and another.)

18179. **Dynamo-electric machines.** Gay and Hammond.

13125. **Carbon holders, etc., for electric welding.** Howard. (Second edition.)

1892.

8875. **Electric motors.** Cooper.

12745. **Electric signalling.** Allison. (Standard Electric Signal Company.)

NOTES.

Pilsen.—The municipality has obtained the consent of the State for the construction and working of an electric tramway, and the scheme already prepared will be carried out.

Rosario.—Calle San Martin, Rosario, has been lighted by electricity, and, in consequence of the dispute with the gas company, it is believed that its use will be extended to other streets.

Birmingham.—The "Looker-on," in the *Birmingham Post*, suggests that it is about time "the Corporation followed the example of the British Museum and other important libraries and adopted the electric light."

Kimberley Exhibition.—A short time ago, visiting the works of Messrs. Mather and Platt, we inspected the electric lighting apparatus which was designed for the Kimberley Exhibition. We understand that the plant is working admirably.

Temesvar.—Negotiations are said to be in progress between the Brush Electrical Engineering Company, the owners of the central station at this town, and the municipality, with a view to the latter purchasing the station. The price asked by the company is 222,000 florins.

Aix-les-Bains.—This well-known pleasure and health resort has been provided with an electric lighting station. The local gas company propose to work the station, but it is said that the municipality have received offers from private individuals to supply electric light 30 per cent. cheaper than the gas company.

Electric Traction in Brussels.—Some time ago the Thomson-Houston Company made certain proposals to local railway companies with a view to the adoption of electric traction on their lines. These offers have been accepted, and the local authorities have given their consent to the construction of three or four new electric tramways.

The Popp System.—It is rumoured that differences have arisen between M. Victor Popp and a number of important shareholders in his company who are German bankers. It is said that the latter wish to interfere with the affairs of the company and put M. Popp in the background. The latter, it is stated, will resign rather than tolerate any interference.

Electric Lighting of Trains.—The Western and Eastern French railways have made experiments in the electric lighting of some of their trains, and although the results were not conclusive, they were yet encouraging. The tests were made with the Meritens battery, which is a modification of the Smée battery. It is proposed to make further tests during the coming winter.

A Miniature Church Installation.—Probably the smallest electric light installation in the world is to be found in the little village of Bremen, near Dermbach, in Thuringia. It comprises a single arc lamp installed in the church, the lamp being energised when required by a small dynamo arranged in the village mill, and driven by the mill wheel by the power of the mill brook.

A Little Mistake.—A lady in the Palace Hotel, San Francisco, requested the clerk to call a messenger boy. Not receiving a prompt answer, she concluded to "press the button" herself. The "button" she happened to select proved to be the electric light switch, and when she operated it the whole first floor of the hotel was thrown into darkness. When light was restored, the lady had vanished.

A New Current Regulator.—Mr. Gustav Cons, of Hamburg, has devised a maximum-current regulator. Its object is to prevent an increase of current over a certain maximum pressure—not as an ordinary lead fuse which completely breaks the circuit, but it renders possible the further passage of the current by the insertion of a resistance. It is proposed to use this device with batteries of accumulators, and in place of electricity meters in house installations.

Cassel.—A report has been published concerning the working of the central station at Cassel, which was started in July of last year. The report is brought down to the end of March last, when there were 180 arc lamps and 2,609 incandescent lamps connected to the mains. This number has since been considerably increased, and electricity is about to be adopted as the motive power in some large works.

Lightning Conductors.—The German fire insurance companies have commenced a scheme to compel policy holders in country districts to erect lightning conductors on the buildings insured. One company proposes that at least two conductors should be erected on each building, the cost to be equally divided. Another company is offering reductions of from 5 to 10 per cent. in the premium to those owners having lightning conductors on their property.

Glasgow.—Some time ago the *Glasgow Herald*—if we remember rightly—gave an excellent series of articles upon the tramways question, and it seems to have commenced another similar series at the present time. In the first of these articles the question of the use of accumulators is discussed, and the conclusion arrived at is that so far accumulator traction has not been a success. In the second, statistics and comments are given on cable traction. The information is up to date.

Dundee.—The men engaged in Tally-street preparing for the electric light, in their digging this week have come across some human bones and also parts of skulls. The vicinity of the East Church favours the idea that in the long past a churchyard must have been located here. It is surprising how many of these relics of the dead are turned up in Dundee streets when for any purpose these have to be opened. Much of the ground throughout the centre of the town seem to have been places of burial.

Newcastle.—It is gratifying to see that the tradesmen are beginning to take an interest in the lighting of the streets, and have induced the Town Council to put up an electric lamp at the junction of Newgate-street and St. Andrew's-street. It has been a difficult job to move the Council to act, for we understand that Mr. Aves and the Newgate councillors' ward have been endeavouring to obtain this boon for the last 18 months. We are glad to find that they have achieved their object in the end.

Hanley.—We are glad to see that the local people are supporting the action of the Corporation in undertaking the work of supplying the electric light. In a few years it is absolutely certain great credit will be given to those who had the foresight to undertake this work themselves, and who had sufficient stamina to laugh at the ever-ready cry of those who would wait till doomsday before taking action. All people who consider the question unbiassedly must see that the properties of electric lighting are so much and so many in advance of those of any other artificial illuminant, that in the long run it is bound to become commonly used.

The Budapest Electric Railway.—According to a report for 1891, the traffic on this well-known electric railway considerably increased during that year. The

length of the line increased from 9·1 kilometres at the end of 1890 to 11 kilometres in 1891, and since then the line has been again extended. The greater portion is double track, and 62 cars are in service. The plant at the generating station has been augmented to 700 h.p. In 1890 758,838 car kilometres were run, and in 1891, 1,489,409 car kilometres. The number of passengers carried in 1890 was 4,459,234, and in 1891, 8,619,215 persons were transported, the receipts being almost double.

Signalling.—Experiments have recently been made from the summit of Mount Washington by means of a search-light, under certain conditions of the sky, by throwing the light upwards at an angle of about 45deg. The reflection was seen about 85 miles. Telegraphic messages by means of flashes were sent from Mount Washington to the Western Union offices in Portland, and answers returned by wire. It is said that this visual signalling by electricity is better by sunlight. We beg leave to doubt it, inasmuch as everyone who could witness the effect of the light upon the cloud could be able to read the intelligence which was being transmitted.

Bowness.—The lighting question has progressed a step further. The proposition is to utilise the water power at Troutbeck Bridge, and the company propose to distribute the light throughout the districts of Bowness and Windermere, the main cable being laid from Bridge Mill to Windermere Station and on to Bowness. At the Board meeting Mr. Fowkes explained all the proposals, and stated that it was not contemplated at first—if the company could obtain the leave from the local authorities—to obtain a provisional order, but the clerk to the Board suggested that it would be advisable to have a provisional order, as the cost would be trifling provided there was no opposition from the two Boards interested in the matter.

Taunton.—The correspondence with regard to the proposed electric light station still continues in the local papers. We have now the astonishing information from Mr Standfast that he estimates the first year's loss at nearly £7,000, but it is difficult to imagine how any sane man can obtain the amount as he does. He puts down as loss, among other things, the procuring of a license £350, and then the procuring of a provisional order £150. We do not quite see that they require both a provisional order and license. Then the paying off of the principal he puts down as loss. Anyone who can give figures of this character must be very hard up for legitimate criticism, and anyone who can accept figures of this kind must be ready to swallow a whale, no matter how large it may be, with his eyes shut.

Rubbish.—A Colonel Henkle proposes to construct a house across the brink of Niagara Falls, and so utilise the power of the falls to drive electric generators, transmitting the power obtained to long distances. Our contemporary *Electricity* suggests that Colonel Henkle should himself be exhibited at the World's Fair, and that he should be allotted ample space. We quite agree with this. Unfortunately, idiotic suggestions of this kind made from time to time, not only in America but in England and on the Continent, are duly telegraphed to our ordinary newspapers and generally meet with the honour of big type. It may be that Colonel Henkle will try to get money on this side for the purpose of investigation. If he does and gets it, the result will be another proof of the old adage—viz., "Fools and their money are soon parted."

Lighting in Spain.—A correspondent of the *Elektrotechnische Zeitschrift* in Spain states that the firm of Planas, Flaquer, and Co., of Gerona, is the only concern in that country which builds dynamos. The company was started in 1857 as an iron foundry and engineering works, and in 1887 an electrical department was added. The lack of coal causes small towns and even villages either to adopt oil or the electric light as an illuminant, gas offering but little competition throughout the greatest portion of the country to the electric light. Water power is used at the Gerona central station, and both alternating (Ganz) and continuous current machines. The same writer concludes that German firms, and it may also be said English as well, who wish to do business in Spain will have to meet the keen competition of the Spanish works, as the Spaniards believe in protecting native industries.

Leeds.—We may add the following information to the note we had in our last issue on this subject. We then said that the company hoped to commence laying the mains in the thoroughfares which it is proposed to light as a commencement. These streets, as our readers are aware, include practically all the area bounded by Wellington-street, Boar-lane, Briggate, Upperhead-row, Woodhouse-lane, Cookridge-street, Park-lane, East-parade, and King-street, and also certain streets beyond this boundary, such as Kirkgate, New Briggate, St. Paul's-street, etc., as well as the entire distance to the Oak Inn, Headingley. The erection of the works in Whitehall-road is progressing rapidly, and the construction of the plant is also in an advanced stage, some of it indeed being already in its place at the works. There seems to be no reason to doubt that the company will, in accordance with their previously expressed opinion, be in position to supply electricity in November.

Electric Traction in Paris.—It is intended to work two tramways in Paris by electricity as soon as the authorisation has been given. The first will start from the Place de la Madeleine, and will terminate at the Saint-Denis (Place au Gueldres), and will be slightly over five miles long. The second line will start in Paris at Rue Taitbout, and will finish at the other end of Saint-Denis, at La Patte D'Oie, and will be nearly six miles long. The cars are of the storage battery type, and 16 will be placed on the two lines. Each car is fitted with two motors of the Manchester type, and the reduction in speed is effected by two sets of gearing. The cars each carry 52 passengers, and the accumulators are contained in six boxes placed under the longitudinal seats. The accumulators have been made by the Société pour le Travail Electrique des Meteaux. The depot will contain four steam engines of 125 h.p. each, running at from 70 to 160 revolutions a minute. These engines will drive Desroziers dynamos, each giving 60 kilowatts. The experiment with these 16 cars will be made by the Northern Tramway Company.

Speed of Electric Launches.—Referring to the notice of the "Electra" for Chicago Exhibition, Mr Magnus Volk writes about the company's claims that, "It is a pity such wild statements are made as to the speed of electric boats. I have fitted up about 15 electric launches from 28ft. to 75ft. long, and I much doubt if in still water (the only true test) it is possible by any means to get an electric launch, under 50ft. long on water-line, to make 12 miles an hour in still water. I have a great many diagrams of speed and electrical horse-power absorbed, and in spite of glib statements of small boats running eight and nine miles an hour, I find that seven miles an hour is about the most to be got out of electric launches, and with the cells in two parallels 4½ to 4¾ miles an hour. Now, admitting that the statement of seven miles an hour is correct for half the E.M.F., putting all cells in series would not give a speed of 12 miles, but only about 10 miles an hour. But from the curves I have, the average shows that the power required increases at a greater rate than the square, in fact, the power curve stands about midway between the curves of the second and third powers. I once tried the

effect of putting double the number of cells in a 40ft. boat, her normal full speed being just over 7½ miles; the result, with all the cells in, was a gain of half a mile, or a bare eight miles an hour.

Indiarubber.—The United States Consul at Singapore reports that there is a royalty charged on rubber collected from the jungles of Borneo of 10 per cent. *ad valorem*. He distinguishes the different species of the plant furnishing gutta found there as follows: 1. *Manungan pulan*, which comes chiefly from North-West Borneo. It is a *Willughbeia barbidgei*, and is specially identical with the "gutta sing garip" of the peninsula. 2. *Maugan buyok*, said to yield the best gutta of the Borneo forest. It is a *Leuconotis engenifolius*. This species is also found in small quantities on the peninsula. 3. *Manugan manga*, which yields a very good gutta, is possibly a *Willughbeia*, as also is *Surapit*, for the latter yields the same milky exudation as *Manugan pulan*, but is said to be a bad gutta, and seldom collected. *Bertabu*, or *Petabo pulan*, is referred to as of little value as gutta, except, perhaps, for adulterating the better kinds. The other kinds of gutta met with in the Malay Peninsula are: (1) *Singgarip putch*, or *Gutta sudek*; (2) *Singgarip hitam*; and (3) *Gutta jelutong*—the latter is only used for adulterating. The guttapercha production and export is much larger than the trade in indiarubber properly so called. The name is given to the inspissated juice, which is produced chiefly by *Dichopsis gutta*, called by the natives *getah taban merah*, and often confused with caoutchouc. The tree is of large size, from 4ft. to 5ft. in diameter, and from 100ft. to 200ft. in height.

Education.—We have received the prospectus of the day and evening classes at University College, Liverpool, for the session 1892-93. It is of course no news to our readers that some of the ablest professors we have are to be found at this college; Prof. O. J. Lodge occupying the chair of experimental physics, Prof. H. S. Hele-Shaw that of engineering, Mr. Francis G. Bailey being demonstrator in electro-technics, Dr. J. L. Howard demonstrator in physics, Mr. Edward E. Robinson being lecture assistant, and Mr. Wakeling laboratory assistant. There are two courses of lectures on electro-technics, one of them elementary, only to be attended by those who have been through the junior course of physics for the session, the other more advanced, and assuming that the student has attended intermediate physics as well. The syllabus matters to be treated during the ensuing session is found in detail in the prospectus, pages 82 to 84. It is, perhaps, a pity that as yet not one of the technical papers has found it expedient to follow the lead of the *Lancet* as regards an educational number towards the beginning of the autumn session. We merely throw this out as a suggestion, for it can hardly be expected that we, who are rather prone to adversely criticising the action of a good many of the professors, can either obtain their patronage or the necessary information in sufficient time to undertake the task, or even to make a suggestion which may be worth their attention.

Accrington.—It will be remembered that we have mentioned the proposal of the municipal authorities of Accrington to purchase the gas and water undertakings of that borough. One of the members of the Council recently enquired whether the Legal and Parliamentary Committee had prepared any report with regard to the electric light in accordance with a resolution passed a month ago. It appears that no such report has been made, but it was stated that as one of an important character had just been received from Mr. Horsfall, who had been going into the question, the committee will be able to give some information at an early date. Mr. Horsfall thinks that the question of the destructors and the electric light go hand-in-hand, and he estimates that when the destructors are erected they will obtain sufficient power to light the Town Hall and the market, and probably a good deal more. There seemed to be, however, a feeling that the position was a somewhat precarious one, in that the time during which their provisional order ran had expired. The old, old arguments were used, that might be summed up in two words, *festina lente*—the members of the Council evidently being of the opinion that other authorities may carry out experiments, and that they would rest and see the result at no cost to themselves. Progress would be delightful, and certainly hardly characterised as rapid, if every business man was to follow the same course.

Photometry.—Mr. Van Choate suggests a new form of photometry, in which selenium cells are employed to receive the light-rays. The instrument is in the nature of a balance connected with a differential galvanometer, the standard light being arranged to affect one side of the balance, and the unknown strength the other. Two lanterns are required, in which the lights are placed, and tubes of these are arranged axially in line. The light to be measured is placed in the right-hand lantern, the standard lamp being in the left-hand. Each tube contains a selenium cell, that in the tube from the standard lamp being adjustable by means of a pinion, and having an index finger moving along the index. Now, taking the right-hand coil of a differential galvanometer, one of the terminals is connected to the zinc pole of the battery, the other to the selenium cell and through the resistance coil to the copper pole of the battery. Similarly, one of the terminals of the left-hand coil is connected to the copper battery, and the other terminal with the adjustable selenium cell and to the zinc pole. The galvanometer can be brought to zero by adjusting the resistance coil. The selenium cells being alike, if the lamps are equal, the distance between the selenium cells and the respective lamps will be the same; if, however, the lamp to be tested is inferior to the standard, the cell facing the standard lamp will have to be moved until the galvanometer shows equilibrium. The difference in the distance between the selenium cells and the lamps is indicated on the scale, and gives the basis for the calculation of the relative intensities of the light of the two lamps, calculations being made according to the law of inverse squares.

Obituary.—Long since the name of Mr. F. N. Gisborne has faded from the view of present-day telegraphists, but in Canada he has been doing good work. On August 30th he passed away from this sphere, wherein he played a prominent part in the history of submarine telegraphy. It was Gisborne who first directed the attention of Cyrus Field to the question of Atlantic telegraphy, and these two gentlemen worked harmoniously and energetically in the realisation of the project. They lived to see it a complete success. Mr. Gisborne, was born in Broughton, Lancashire, England, March 8th, 1824. In 1842 he started on a tour around the world which lasted nearly three years. He finally settled, in July, 1845, in Canada. But he was not long content with the life of a farmer. He had a keen interest in telegraphy, and in 1847 he deserted his farm for a place in the office of the Montreal Telegraph Company. Not long afterwards he opened the first office of the company in Quebec. He advanced rapidly, and in 1850 he was the chief officer of the Nova Scotia Telegraph Company. About this time he conceived the idea of connecting Newfoundland with the American continent, and though the work led through adversity, and even through prison, he was constant in his efforts, and

finally carried it out, and further, for not only Newfoundland, but Europe was through this initiative connected with the American continent. After the cable was finally laid, Mr. Gisborne was appointed superintendent of the Canadian Government Telegraph and Signal Service, an office that he held until his death. He was the inventor of a number of valuable electric and other appliances. He was one of the original members of the Royal Society of Canada.

Electric Transmission.—Some time ago Mr. E. Griffin read a paper before the Franklin Institute on "The Electric Transmisson of Power," which paper has been published in the September number of the *Journal* of the institute. There are a few conclusions and statements to which we should like to direct attention. He points out various truisms, such as that the latest types of dynamos are built to run with slow armature speed, and in this respect the electrical manufacturers are gradually approaching the engine makers. Engines work most economically under full load. A mean of several electric railway power stations shows the average load to be about 60 per cent. maximum, and in lighting stations running for 24 hours the changes are of course much greater. In the latter case it is imperative that the same plant be divided into numerous units, which can be gradually brought into service according to the demand. The size of the dynamo should be proportionate to the total works of the station. There should never be less than two generating units, and preferably more. With a total of 250 h.p. it would be poor practice to have but one 250-h.p. dynamo. Three eighties would be far preferable. With a total of 2,000 h.p. it would be poor practice to have 25 80-h.p. dynamos. Eight to 100 fifties would be preferable. As we say, these truisms are reiterated in this paper, and cannot be too often driven home, and especially when there are numbers of young engineers attempting to design stations. They are more likely than older men to lack the guiding reins of experience. The paper, however, contains a good deal of information as to various stations all over the world, and in connection with the electric railways of the States it is said that last year no less than 119,264,401 passengers were carried on the cars, and not a single individual has ever been killed or seriously injured by the trolley current. This does not mean that there have not been very sad accidents, but they are accidents similar to those which occur with any system.

Use of Secondary Batteries.—A pamphlet under this title, by Jules Bourquin, is published by Gustave Thiriart, of Liege. This little 24-page treatise is an extract from the *Proceedings* of the Association des Ingénieurs Electriciens Sortes de l'Institut, of Montefiore. In the literature of secondary batteries the chemical action involved in the formation, charge, and discharge, also the management and descriptions of the various types, has been fairly well treated; but hitherto little has been done in the direction of indicating the best conditions under which they may be commercially applied. The treatise before us, however, is an attempt in this direction. In the treatment of his subject, the author divides it into two parts. Chapter I., in which are considered the most efficient methods of charging and discharging the cells, a subject that has been well discussed and fully ventilated in this country, terminates with a *résumé* of the work already done in this direction by various investigators, chiefly continental. Probably many in this country will scarcely agree with the author's assertion that little or nothing has been done in the way of determining the chemical action in storage cells since Gaston Planté gave his invention and the result of his experience to the world at large. Some stress is laid upon the necessity of having an alarm for suitably indicating a hurtful condition of charge and discharge, and the apparatus of M. Fein, of Stuttgardt, devised for this purpose, is alluded to. Chapter II. treats of the best and most commercially economical methods of utilising secondary batteries, whether they be of the pasted or Planté types. Referring to portable accumulators suitable for miners' lamps, the Swan, whose weight is given as 3·2 kilogrammes for an electrical capacity sufficient to give between 10 and 13 candle-power hours, is quoted as being a step in advance; but we imagine that several makers of these commodities can show superior results to this. Altogether, M. Bourquin's little pamphlet will well repay a perusal by all those interested in accumulators.

Prize Competitions.—At the last prize contest instituted by the city of Paris for the best electric meter, the prize of 5,000f. was awarded to Prof. Elihu Thomson. With the desire that this sum should serve for the development of the theoretical knowledge of electricity, he has requested M. E. Thurnauer, general manager for Europe of the Thomson-Houston International Electric Company, to offer a prize for the best work on a theoretical question in electricity, and to organise a committee who should propose the subjects, examine the productions, and decide the prize. The committee has decided that the prize should be given for an investigation on one of the following subjects: 1. The heat developed by successive charges and discharges of condensers under different conditions of frequency, nature of dielectric, and quantity of charge. 2. It has been shown theoretically that when the two surfaces of a condenser are connected by a conducting body, the condenser becomes the source of alternating currents as soon as the resistance of the conducting body decreases below a certain limit. The formula that permits calculating the period of this oscillation has not yet been completely verified. This period of oscillation should be investigated experimentally, under conditions such that the exact measure of resistance, capacity, and coefficients of self-induction may be possible, in order to arrive at a complete and precise verification of this formula. 3. When a condenser made with an imperfect insulating material has been charged and then left to itself, the charge is gradually dissipated. The time necessary for the charge to be reduced to a given fraction of its initial value depends only on the nature of the insulating material. It is proposed to investigate whether, as certain recent theories would seem to indicate, analogous phenomena do not present themselves in metallic conductors, and whether these can be shown experimentally. 4. It is proposed to arrange and systematise our present knowledge of the graphical solutions of electrical problems, and deduce from them some general methods, as in graphical statics. The theses presented may be written in English, French, German, Italian, Spanish, or Latin. They may be in manuscript or printed. The papers must be sent before Sept. 15, 1893, to B. Abdank-Abakanowicz, consulting engineer, 7, Rue du Louvre, Paris.

Cost of Electric Traction.—The West End Street Railway of Boston is now operating 1,000,000 electric car miles per month. In June the revenue electric car mileage was 846,987, in July it was 971,862, and for August it will exceed 1,000,000 miles. The result of this larger electrical mileage is seen in a decreased cost of maintenance and motive power per car mile. In July it was 4·56 cents, against 5·06 cents in June. The total cost of electrical motive power and maintenance in July was 90,320dols., against 87,956dols. in June, and yet the car mileage was 124,875 miles, or 14 per cent., greater. In August, with

1,000,000 miles run, there is no increase in the number of employés. The statement for the month of July is as follows:

	Total.	Electric.	Horse.
Gross receipts	$603,415	$383,149	$220,266
General expenses	27,246	16,666	10,579
Track and car expenses ...	168,716	105,602	63,113
Motive power..................	120,811	50,777	70,033
Total operating expenses ...	373,838	212,589	161,248
Net earnings	229,577	170,559	59,017
Miles run	1,588,663	971,862	616,801
Ratio mileage...................	100	61.17	38.83
Percentage of expenses ...	61.95	55.48	73.20
Earnings per mile run	37.98c.	39.42c.	35.71c.
Expense per mile run :			
Motive power	07.61	05.22	11.36
Other expenses	15.92	16.65	14.68
Total expenses	23.63	21.87	26.14
Net earnings per mile run...	14.45	17.55	9.57

The following table shows gross and net earnings by months for May, June, and July compared with last year:

Gross earnings:	1892.	1891.	Inc.	Dec.
May	$540,846	$521,086	$19,760	—
June	600,450	551,592	48,858	—
July	603,415	555,739	47,673	—
Total	$1,744,711	$1,628,417	$116,294	—
Expenses:				
May	$339,306	$364,210	—	$24,904
June	368,416	353,135	$15,281	—
July	373,838	366,317	7,521	—
Total	$1,081,560	$1,083,663	—	$2,102
Net earnings:				
May	$201,539	$156,875	$44,664	—
June	232,033	198,456	33,577	—
July	229,577	189,422	40,155	—
Total	$663,151	$544,754	$118,396	—

Electric Cranes.—From the Institution of Civil Engineers' *Abstracts* we note that Mr. C. J. Bates has in the *Railroad Gazette* described a "100-ton" (*i.e.*, 200,000lb.) crane built for the Baldwin Locomotive Works by W. Sellers and Co., of Philadelphia. The crane consists of a rolling bridge of two parallel girders of 74ft. 8in. span, and 7ft. deep out to out, placed 9ft. 3in. apart, and carried by four 5ft. wheels, with double-flanged steel tyres, the wheel base being 14ft., and the rails weighing 360lb. per yard, and carrying a rack of 2¼ pitch and 4in. face in which work the travelling gear wheels. As the crane has to lift a locomotive by both ends, there are two hoisting trolleys, which run on rails carried by the lower flanges of the main girders, and each trolley is in itself a complete hoisting machine. The source of power is a dynamo, the terminals of which are connected to two $\frac{7}{8}$in. rods of copper, supported on yellow pine strips and glass-insulated. On the rods run a pair of small four-wheeled trolleys of the Wheeler type for picking up current. Each trolley is coupled to a 40-h.p. United States Electric Light Company's motor of constant speed, shunt wound for a 220-volt current. Their speed is 500 revolutions per minute. They stand on the top of the bridge over the operator's platform, and are belted to the gearing below, which operates the hoisting trolleys, one set of gearing being on each side of the bridge. The two systems are connected by a belt across the bridge, and, so far, there has been no burning of either motor, as might occur if one motor overran and turned the slower one into a dynamo. The systems of gearing, made up of various clutches, etc., transmit power to the hoisting trolleys through three square shafts to each trolley, and on each trolley, for hoisting or lowering, there are four speeds—viz., 5, 10, 20, and 40ft. per minute, and two traversing speeds, 50ft. and 100ft. per minute. A special clutch holds the weight, and prevents a "run" when changing speed or direction. The hoisting-block has two sheaves, and the chains are also in two parts, and the winding of the drums runs towards the middle, so that an object is lifted vertically. Each trolley will lift 100,000lb. On one trolley there is a small 5-h.p. Wenstrom motor and hoisting gear for small weights. There are nine levers to be worked by the operator, and they are arranged to be moved in the direction of motion intended to be given to the loads, as far as practicable.

Miners' Electric Lamp. — The following note appeared in the *Times* of a few days since. We give it for what it is worth, but in our estimation the practical value is infinitesimal. However, we may be wrong, and for the sake of miners hope a suitable lamp has been obtained: "Various attempts have been made to supersede the miners' oil lamp in collieries and other underground workings by the electric light, and of late considerable progress has been made in this direction. The attempts have largely been made in connection with secondary or storage batteries, but it is considered that the conditions of working can best be met by a lamp taking its current from a primary battery, which principle has also been laid under contribution. The main difficulties which have hindered the general introduction of electric lamps underground appear to have been excessive first cost and heavy cost of maintenance, limited duration of light, great weight, and the necessity of skilled labour for their adjustment. These hindrances appear to be overcome in the electric lamp invented by Colonel Engledue, R.E., of Byfleet, Surrey, which constitutes the latest example of electric lamp for mining purposes. In this lamp the current is derived from a primary battery, which is enclosed in a wood case measuring 6½in. high by 5in. wide and 3in. thick, and having a middle partition forming two cells. The cells are lined with lead, to which are attached carbon plates, four in each cell, thus bringing the carbons and lead into electrical circuit. The top of the battery is hermetically sealed by an ebonite cover, which is screwed down to the wood casing, an india-rubber washer being interposed. Two ebonite plugs are screwed into the ebonite cover, one over each cell, each plug carrying a round zinc element which dips into the depolarising resolution. The lamp has a fixed wood cap, and contacts are made in the usual manner with a small glow lamp placed in front of the case and protected by a small lantern with a reflector. The electrolytic fluid consists of a solution of sulphuric acid, hydrochloric acid, and bichromate of soda, with which the cells are charged to within about an inch of the top. After the lamp has been running for about four hours it is turned upside down, and instantly fitted for work again by the aid of an ingenious handle, which can be reversed and locked by a simple movement and without detaching it from the lamp. The reversal gives the zinc elements full immersion in the electrolytic fluid, and the lamp yields a light for another six hours or more, bringing the total duration of light up to over 10 hours, the practical constancy of the light being maintained. Tests of this lamp in workings show that it gives a sufficient light for mining purposes for 10 hours or longer, while the cost of maintenance is stated to be about 6d. per week per lamp. The first cost of the lamp is put at 15s., while its weight when charged for use does not exceed 5lb. In view of the importance in collieries of a light which cannot be exposed without being instantly extinguished, it is to be hoped that the lamp under notice, which appears to meet the requirements of both masters and men, will find a speedy and wide adoption."

PRACTICAL INSTRUMENTS FOR THE MEASUREMENT OF ELECTRICITY.

BY J. T. NIBLETT AND J. T. EWEN, B.SC.

VIII

(*Continued from page 183.*)

RESISTANCE, *continued.*

Post Office Forms of Wheatstone's Bridge. Some of the earliest examples of the Post Office form of Wheatstone's Bridge consist only of the variable known resistance R_1, and the two ratios R_2 and R_3, together with binding screws for connecting up the galvanometer, the battery, their contact-makers or keys, and the unknown resistance R. An example of this class of instrument is shown in Fig. 15, which illustrates what is known as the Post Office Wheatstone's Bridge, Old Form. The battery circuit is shown with a key K_1 for reversing the direction of the current, while the galvanometer has a simple contact maker K_2. With the exception of the resistance coils themselves, which are shown dotted in Fig 15, this form of the apparatus has no underboard or concealed connections whatever,

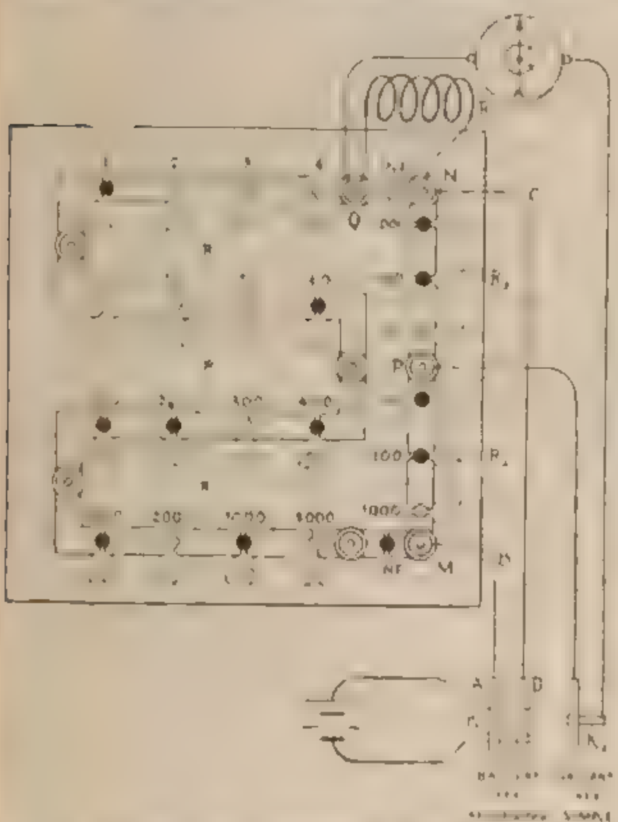

FIG. 15.—Post Office Wheatstone's Bridge—Old Form.

so that the whole arrangement will be readily understood from the diagram, which shows the apparatus connected up in readiness for making a measurement.

The resistance coils, the construction, calibration, adjustment, etc., of which will be treated in a subsequent article, usually consist of lengths of high-resistance insulated wire wound on bobbins or spools which are fixed underneath the baseboard, the ends of the coils being connected in such a way to the brass or gun-metal junction-pieces above, that when the plug between any two adjacent junction-pieces is removed from its seating, the circuit then includes the coil directly beneath. Each coil is carefully calibrated so as to have the exact resistance indicated on the baseboard above. The wire, which is usually of German silver, platinoid, or platinum-silver alloy for the better class of instruments, is wound double on the bobbins to prevent self-inductive action in a coil when a current is sent through it. The baseboard of the instrument, on which the junction-pieces are fixed, consists of a slab of insulating material, usually vulcanite, and the tapered plugs for inserting between the junction-pieces when it is desired to cut out the resistances bridging the gaps between them are usually of the same metal as the junction-pieces themselves, and are provided with vulcanite insulating handles. These plugs are all carefully fitted to their seatings so as to afford a large surface of contact which will offer little or no resistance to the passage of an electric current, and they are made interchangeable so that any plug can be used for any gap.

FIG. 16. Post Office Wheatstone's Bridge—New Form.

Many forms of short-circuiting junction plugs have been from time to time suggested, but the very slightly tapered round plug (of which those used in the instrument illustrated in Fig 16 are examples) now almost universally used, has been found to give the best results owing chiefly to its self-cleaning properties and the excellent contact obtained through the screw-like wedging action when it is pressed and turned in its socket

In the Post Office Wheatstone's Bridge, New Form, of which a commercial example is shown in Fig. 16, and a diagrammatic representation (showing all the connections made in readiness for measuring a resistance) in Fig. 17, the galvanometer and battery keys are both incorporated in the instrument itself, as well as the ratios R_2 and R_3 and the known variable resistance R_1. Besides the addition of the keys K_1 and K_2, it will be seen on comparing Figs. 15 and 17 that the known variable resistance R_1 is arranged in a more compact manner in the new form of the instrument than in the old. The underboard connections from the keys are shown

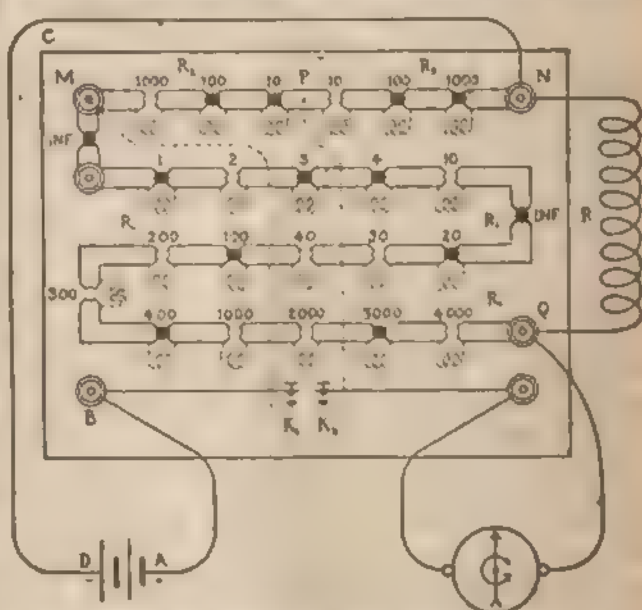

FIG. 17.—Diagram of Post Office Wheatstone's Bridge—New Form.

dotted in Fig 17, the dotted lines representing thick pieces of copper wire which offer practically no resistance to the passage of an electric current through them. The battery key K_1 is connected to M, the point where the ratio R_2 joins the known variable resistance R_1, and the galvanometer

key K_2 is similarly connected to the point P between the two ratios R_2 and R_3.

In both of the examples here shown the coils in the variable known resistance R_1 are arranged on the 1, 2, 3, 4 system, and the two ratios R_2 and R_3 consist of three coils of 10, 100, and 1,000 ohms each. In the New Form, Fig. 17, both of the infinity plugs must be in their places while a measurement is being made, but in the Old Form, Fig. 15, the plug between the binding-screws Q and N must be removed, so as to throw into circuit the unknown resistance R whose ends are connected up to Q and N.

In the example of Post Office Wheatstone's Bridge, New Form, shown in Fig. 16, the instrument is fitted in a polished mahogany case provided with a dust-proof lid which renders it very compact and suitable for travelling.

The binding-screws used in the various forms of Wheatstone's Bridge, and in a large variety of other electrical instruments, usually consist of a shoulder and projecting screw on which are fitted a pair of faced-up nuts with milled edges, two nuts being provided to facilitate the connecting up of two or more separate wires to the same binding-screw. Sometimes additional provision for making connections is afforded by an extra nut on a stud projecting at right angles from the side of the binding-screw, instead of putting both the nuts on the same spindle.

To render these instruments more serviceable and convenient when used for throwing resistances into circuits or for other purposes, it is usual to provide them with more binding-screws than are absolutely necessary for ordinary measurements on the Wheatstone's Bridge principle. If in using either of the instruments illustrated in Figs. 15-17, in the ordinary way, it is found that the known variable resistance R_1 is too small, additional resistance may be thrown in by removing the infinity plug at the bottom right hand corner in Fig. 15, or at the top left-hand corner in Fig. 17, and connecting up the additional resistance to the screws at the side of the gap. Provision for throwing in additional resistance when necessary is similarly allowed for in the various other forms of these instruments.

(To be continued.)

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

I.—EVOLUTION OF ELECTRICAL ENGINEERING.

ADVANTAGES OF THE ELECTRIC LIGHT.

A pure and healthy atmosphere is dependent upon the amount of oxygen present, and the following are the percentages of gases which, being mechanically mixed, form the atmosphere:

Oxygen	23 per cent.	by weight.
Nitrogen	77 „	
Total	100	

There are, in addition, very small quantities of carbonic acid gas (CO_2), hydrogen, ammonia, and organic matter.

All substances and matter, when burning, consume oxygen—that is to say, the act of combustion of any matter signifies the chemical combining or mixing of the vapours of the burning matter with the oxygen of the atmosphere. Hence if matter be burnt in a closed vessel containing atmospheric air, the matter would continue to burn until it had abstracted all the oxygen out of the air, and when that stage had been arrived at, the combustion would cease through lack of oxygen; the volume of the new gas thus given off is often poisonous, according to the nature of the article burnt. The most common ways of obtaining light is by oil, candles, or gas. Of these three, candles are the most unhealthy light, because they abstract more oxygen from the air than the other forms of illumination; all three vitiate the atmosphere and give off poisonous fumes, the carbon which they contain mixing with the oxygen from the air, and so producing the deadly carbonic acid gas, known to chemists as carbon dioxide, or CO_2. The operation of breathing has a similar effect on the atmosphere—pure air is inhaled by the lungs, but impure air, containing carbonic acid gas, is exhaled. It is this that makes a room close or stuffy when a person has been sitting in it any length of time with doors and windows closed. One gas jet of 14 c.p. consumes about 20 cubic feet of air per hour. A man with good respiration will consume about four cubic feet of air. From this it will be seen that one gas jet vitiates a room to the same extent as four persons would do.

The following table shows forcibly the weight of the preceding remarks, each illuminant giving a light of 12 standard candles for one hour:

Illuminant.	Cubic feet of air consumed.	Cubic feet of carbonic gas produced.	Cubic feet of air vitiated.	Heat evolved in lbs. of wat'r raised 10°F.
El'ctric light	None.	None.	None	13¾
Common gas	17¼	3¼	348¼	278¾
Paraffin oil .	34	4½	484	362
Wax candles	42	6	632¼	383

Illumination by means of the electric light keeps the atmosphere pure and cool. Respecting the first claim—namely, that of purity—the proof is made self-evident by simply stating that the light is enclosed in an air-exhausted and hermetically-closed glass bulb, thus absolutely severing the light from any contact with the atmosphere. Under these conditions the lamp filament cannot burn, through absence of oxygen; hence there can be no evolution of heat from combustion. Most people fancy that the electric light does not give out heat; this is a very great mistake, since there can be no light without heat. When a substance burns, its atoms unite with the oxygen atoms of the atmosphere, and this chemical affinity causes such a great evolution of heat that the particles are raised to a state of incandescence, or white heat, consequently we obtain light.

In the case of an electric incandescent lamp, the small amount of heat evolved from it is due to the high temperature of the lamp filament, and on account of the vacuum in the lamp there is no conducting medium for the heat, which is thereby much diminished. This is shown by taking in the hand a glow lamp that has been burning some hours; it will be found that there is a comfortable degree of warmth without burning the hand. Compare this with the effect of placing the hand close to a gas jet of equal candle-power, and a practical example is found at once of the relative heating properties of the two illuminants.

The great value of the electric light and the boon it confers cannot be over-estimated, particularly when it is introduced into manufactories, mills, shops, etc., where the articles about are of a highly inflammable nature, and the danger of fire so great in the presence of naked gas light. The act of lighting by electricity can be done automatically and instantaneously throughout the whole of a large establishment; this avoids the risks and dangers of gas lighting by hand, as well as time and labour, and therefore expense in so doing.

The best proof that can be put forward as to the great safety in the use of the electric light, is that the insurance companies look upon its introduction with favour, yet it must be borne in mind that the insurance people have had to draw up very drastic rules in order to protect themselves and the public, and the electrical industry should be greatly indebted to them on this score, because without any such compulsion unscrupulous firms would scamp their work, thus throwing discredit upon the whole industry. These kind of people never hesitate to do electrical work at prices with which a good firm putting in good work cannot possibly compete. Following in the wake of this type of contractors comes a long train of nondescript individuals, who take unto themselves the title of electricians, electrical engineers, or anything else to the purpose that suits their fancy. These enterprising gentry recruit their ranks from tinkers, plumbers, ironmongers, bellhangers, and such like, and trade upon the ignorance of the public. This is one of the attendant evils that dog the progress of a new industry—a veritable "old man of the mountain," and the same thing occurs in the development of every industry. Time only can cure it. In conclusion, it may be said that *the electric light is the safest of all illuminants, provided that the work of instalment is well and conscientiously carried out.*

Before concluding these remarks, there should be pointed out one other advantage which the electric light possesses, and a matter of paramount importance—namely, the health and personal comfort. Who is there who has not felt the exhausting and injurious effects of a heated and contaminated atmosphere? The stifling feeling in a theatre, or any other place where there is a number of people, is partly due to them, and partly due to the gas lights. The same applies to workrooms of every description. That a substantial improvement is wrought by the introduction of the electric light there is no shadow of a doubt. In the General Post Office, St. Martin's-le-Grand, the electric light costs £700 per annum, but a healthier atmosphere is procured, and the great benefits and comforts which it bestows on the employees is such that it has diminished the hours of absence two hours per day. In addition to this, the staff are able to work better and quicker, due to the absence of the lassitude so often felt in heated atmospheres. Mr. Preece, the chief electrician, considers the increased amount of work obtained from the staff very nearly pays for the cost of lighting.

Cost of Electricity v. Cost of Gas.

A great deal of misleading and incorrect matter has been published concerning the relative cost of gas and electricity. Some writers have made electricity two to three times the cost of gas; others, again, have erred in the opposite direction, and tried hard to show conclusively that it is quite as cheap as, if not cheaper than, gas. The author is of opinion that neither party is correct. The cost of electricity depends a great deal on the circumstances and conditions of production. To show clearly what is meant by this, take the case of a large mill, owner, who has, say, a 200 h.p. steam engine; from this, 20 h.p. can easily be reserved for driving a dynamo, very little more coal will be burnt, scarcely any attention required, the only outlay of money being for the dynamo and fixing up of lamps—here the cost of the light will be far below gas, possibly not much more than one half. Now, take the other extreme, buying current from an electric supply company in London; the general charge is 7½d. per unit, and this works out to an equivalent cost of 6s. 4d. per 1,000 cubic feet of gas, which is more than double the average cost of gas at 3s. per 1,000 cubic feet. From these two examples the reader will at once perceive how absurd it is to make a sweeping solution of a problem which admits of two such diverse interpretations. A detailed comparison between gas and electricity will now be made, assuming the electricity is supplied from a central electric light station, just as gas is supplied from gas works, for this is the way the general public will obtain their electricity.

(a) Comparison with a Glow Lamp.

An ordinary sized gas jet, such as is found in all private houses, may be judged to give out 14 actual candle power, when in good condition, the consumption of gas being taken at the rate of five cubic feet per hour, the gas being of good quality and at a normal pressure. With gas at 3s. per 1,000 cubic feet, the cost of five cubic feet would be 0·18 penny, so that one gas jet of 14 c.p. burning for the space of one hour would cost 0·18 penny, or little less than one-fifth of a penny, or one penny if burning for five hours; and for 1 c.p. the cost would be 0·013 penny or one seventy-seventh ($\frac{1}{77}$) of a penny, or one penny if burning for 77 hours—1 c.p. being taken as the standard measure of light as given out by a pure spermaceti wax candle which consumes 120 grains of wax per hour. Passing on now to electricity, assume the price of current is 7½d. per Board of Trade unit, this being the charge made by the Metropolitan Supply Company in London, and is a fair average price. A unit signifies a certain amount of electrical energy (1,000 watts) acting for the duration of one hour. An incandescent lamp of 16 actual candle-power requires 56 watts or 3·5 watts per candle-power; this works out at 0·025 penny, or $\frac{1}{40}$ penny, per hour for 1 c.p. Besides this cost there is the cost of the lamp itself to be considered. An incandescent lamp costs 3s. 9d., and on an average has a life of 1,000 hours, at the end of which time the filament breaks, or the lamp becomes so blackened that its light-capacity is worthless. Therefore, the cost of the lamp comes to ·0028 penny, or one three hundred and fifty-seventh of a penny ($\frac{1}{357}$ penny) per hour of candle-power. Adding these two costs together we have

Cost of current	=	·0250 penny
Cost of lamp	=	·0028 „
Total	=	·0278 penny.

Hence	1 c.p. per hour from gas	=	·013 penny
	1 „ „ „ electricity	=	·0278 „
or	14 „ „ „ gas jet	=	·18 „
	16 „ „ „ glow lamp	=	·44 „

Gas being reckoned at 3s. per 1,000 cubic feet, and electricity at 7½d. per 1,000 watt hours. ·44 penny means a trifle under one halfpenny, so that in practice it is usual to take the running cost of a 16 c.p. glow lamp at one halfpenny per hour. Similarly, the cost of an 8 c.p. glow lamp is put down at one farthing. Of course this only applies when the cost per unit = 7½d. If the cost be less than 7½d., say 6d., which is what the St. Pancras Vestry charge, then the cost of a 16 c.p. glow lamp per hour would be $\frac{1}{2} \times \frac{6}{7\frac{1}{2}} = \frac{2}{5}$ penny nearly. When the number of lamps used and the hours that they are burning are a fixed number, say in a business establishment, it is very easy to arrive at the total cost of the light. Suppose 50 lamps of 16 c.p. are lit at dusk every day, except Sundays, until 8 p.m., upon referring to the table of the lighting hours given at the end of the book, it is seen that the number is 742; as Sundays are excluded, one-seventh of this ($\frac{742}{7} = 106$) must be deducted, leaving 742 − 106 = 636 hours of lighting, so that ½ × 50 × 636 = 15,900 pence = £66 5s., using electricity at 7½d. per unit.

From the figures given above, it is seen that electricity in the form of glow lamps costs more than double gas, since ·0278 is more than twice ·013, therefore the equivalent cost of gas to bring the price up to that of electricity must be—

$$\frac{3 \text{ shillings} \times \cdot 0278}{\cdot 013} = 76 \text{ pence} = 6s.\ 4d.$$

The table below is taken from a paper written by the author, entitled "Shall Gas Undertakings Supply Electricity?" (see *Transactions* of the Incorporated Gas Institute, 1890), and is worked out to give the equivalent cost of gas for different prices per unit of electricity, the figures here being corrected ones.

	Pence.								
Per unit of electricity	4	4½	5	5½	6	6½	7	7½	
Per 1,000 cubic feet of gas	42	48	53	58	64	69	74	79	
Per unit of electricity	8	8½	9	9½	10	10½	11	11½	12
Per 1,000 cubic feet of gas	85	90	96	101	106	112	117	123	128

The above figures relate only to lighting by means of incandescent or glow lamps, and not to arc lamps. It will be observed that by multiplying the price per unit of electricity by the number 10½, we obtain the corresponding equivalent cost per 1,000 cubic feet of gas. For example, let 5½d. be the cost of a unit, then 5½ × 10½ = 58, and on referring to the table it will be seen that 58 is given as the equivalent cost of gas.

(b) Comparison with an Arc Lamp.

When the greatest economy is required, arc lamps should be used; this kind of electric light is particularly suitable for large spaces, such as building yards, warehouses, etc. A 1,200 nominal candle-power arc lamp takes about 330 watts, or one-third of a unit, and may be said to give out about 480 actual candle-power when a thin ground glass globe is used. With electricity at 7½d. per unit, this works out to ·0053 penny per candle-power per hour. There is now to be added the cost of the carbon consumed in the lamp. This may be put down at ⅗d. per hour, therefore this equals ·00125 penny per candle-power per hour. Adding both together, we have

Cost of current	=	·0053 penny
„ „ carbon	=	·00125 „
Total	=	·00655 „

Hence an arc lamp giving 480 c.p. actual, or 1,200 nominal, costs about 3d. per hour.

It was found that the cost of gas at 3s. per 1,000 cubic

feet was ·013 penny per candle-power per hour—hence the equivalent cost of gas is

$$\frac{3 \text{ shillings} \times \cdot 00655}{\cdot 013} = 18 \cdot 1 \text{ pence, or little more than 1s. 6d}$$

From this it appears that an arc lamp of 480 actual candle-power, when using a thin ground glass globe, only costs about one half the price of an equal amount of light from gas. This is, taking gas at 3s. per 1,000 cubic feet, and electricity at 7½d. unit, and with these same prices for gas and electricity, it was shown that a glow lamp cost more than double that for an equal amount of light from gas, hence the arc lamp costs less than one fourth the cost of a glow lamp for equal candle power. In the case of the glow lamp, the equivalent cost for gas was obtained by multiplying the price per unit by 10½, and since the arc lamps costs less than one-quarter of the glow lamp, therefore multiplying the price per unit by 2½ gives the equivalent cost for gas in the case of arc lamps.

The tabulation below shows in a brief form the respective costs per candle power per hour for arc lamp, glow lamp, and gas jet; also the cost of their respective full candle-power, and finally the ratio of their cost, taking gas as a standard at 100.

Illuminant.	Cost of 1 c.p. per hour.	Full c.p. per hour.	Ratio.
Arc lamp.	·00655 or [illegible] penny	For 480 c.p. = 3 pence	51
Glow ,,	·027 or [illegible] ,,	,, 16 c.p. = ½ penny	207
Gas jet.	·013 or [illegible] ,,	,, 14 c.p. = ¼ ,,	100

Take an establishment lit by arc lamps, say 10 in number, and running the same hours as was given in the example with glow lamps, that is 636, excluding Sundays. At 3d. per lamp per hour, this $= \frac{636 \times 3 \times 10}{20 \times 12} =$ £79. 10s., and is the cost per annum for illuminating power equal to $10 \times 480 = 1,800$ candles, or about 342 5ft. gas jets.

All the above calculations have been based on the standard size of lamp, or that size most commonly used—that is, 16 actual candle-power for glow lamps, and 1,200 nominal, or 480 actual, for arc lamps. As the lamps, both glow and arc, increase in candle power or size, so the electrical power consumed by them becomes slightly less in proportion to the candle power. Hence, their cost will become slightly less also, but against this advantage it must be remembered there is a greater concentration of light, which is a disadvantage. This matter will be discussed fully further on.

Economics of the Electric Light.

So far nothing has been said concerning the numerous small savings that electricity effects. The above detailed comparison of cost simply refers to direct charges. Upon examination, we shall find that the direct charges, or what may be termed "prime calculated cost," will be considerably altered in value. Take into account the great waste of gas that occurs through lights being left burning unnecessarily. How many times a day are gas jets left full on upon the occupier leaving a room for, say, 10 minutes? It is too much trouble to turn the gas out, and particularly to relight it, matches are not always at hand, and groping about in the dark is very unpleasant—a feat more often than not attended with knocking your head or shins against articles anything but soft. Turning out the gas or lowering it may seem to effect a very trifling saving, but it is these trifles that soon add up into a respectable total, and "many a mickle makes a muckle." Three times 10 minutes every day signifies close on a couple of hundred hours per annum. Now perform this operation on half-a-dozen gas jets or glow lamps; it reaches the total of nearly 1,100 jet or lamp hours, or equivalent to one jet or lamp burning for 1,100 hours. In the case of gas this signifies not far off a sovereign wasted, and in the case of electricity more than a couple of sovereigns saved. Where electricity is employed as a lighting medium there is not the slightest excuse for such needless waste, because by fixing the switch close by the entrance door the light can be immediately switched on before entering the room, similarly the light need not be switched off when leaving the room until just at the door. Only those who have experienced it can appreciate the comfort of the electric light in a bedroom, with the switch fixed close to the bed head, and ready t light up or turn out in an instant. Another matter of con siderable importance is the great saving that electricit ensures with regard to expensive decorations, whethe metal work, paint, curtains, and draperies of delicate hue moulding, statuary, and the thousand and one beautifu things that adorn a handsome hall or room. Such place as theatres, hotels, public buildings, etc., recognise thi and it is common knowledge that some of the highly decorate places of amusement save a very heavy sum annually, whic inevitably must have been spent had gas been the illuminan Whilst speaking about amusement places, hotels, etc., it ma readily be inferred that those which possess the cool atmo sphere due to electric lighting are more likely to, and in fac do, obtain a greater share of patronage than the others, othe things, of course, being equal. Each reader can now plac his own figure of value on the foregoing economic featur of electricity, and this, deducted from the "prime calculate cost" of electricity, will give a fair idea of the "true absolu cost" of the electric light as compared with gas.

(To be continued.)

ON THE PHYSICS OF THE VOLTAIC ARC.*

BY PROF. SILVANUS THOMPSON, F.R.S.

The author said if one measured with a voltmeter th difference of potential between the two electrodes of th arc you find, when the arc is steady, the total voltage a observed is something over 40 volts, and it is known tha part of this varies with the length of the arc and th current sent through the arc, and that part is practicall independent of either the current or the length. There i a constant part and another part, which varies nearl directly as the length of the arc when the current is co stant, and nearly inversely as the current when the lengt of the arc is constant. A useful approximate formula fo the steady arc is $e = a + b\frac{l}{i}$, where a and b are constant l the length of the arc, and i the current. The constant varies between 35 and 39 volts; whilst when l is given i millimetres and i in amperes the constant b has value between 8 and 18.

Now, this constant part of the voltage, which is indepe dent of the strength of the current for an invariable lengt and independent of the length of the arc for an invariabl current, is sometimes called the apparent back E.M.F. of th arc. The arc acts as though it were the seat of a bac E.M.F. I am not saying there is actually one, only that acts as though there were. It is possible to account for th thing equally well by saying that there is somewhere in th arc a resistance which proportions itself always inversely t the current. Now, how can any resistance proportion itse so to the current? It can only do so in the following wa If there is at any one surface of the arc a something equiv lent to a transition resistance, then if that varies inversel with the area over which it takes place, and if the area ov which it takes place is proportional to the current, then yo might have something of the kind to explain this. Som years ago I explored the question of the seat of this su posed back E.M.F., and established, by means of th measurements made with a third movable electrode, that th seat of this E.M.F. was at the crater. This was when takin the ordinary method of producing the arc between two carbo electrodes, an upper and a lower. I explored where th great drop of potential, 35 to 39 volts, occurred. I foun that the drop of potential along the arc only amounted t a few volts, and where the great drop took place was a the surface of the positive electrode or crater. This where most of the work of the arc is done. That bein settled as to position, the next question was, what was th physical process going on there which would require suc absorption of energy which made this great fall of voltag and I could only account for it at the time by supposin that the volatilisation of the carbon required it. I was le to this by various reasons, one being Captain Abney's di covery that the surface of the crater is always of an equ

* Paper read before the British Association at Edinburgh.

intensity; the brilliancy for the same quality of carbon per square centimetre was always the same. I was led by that to think it must be simply a question of volatilisation.

Quite recently, however, Mr. Crookes has made the observation that the flaming discharges produced by alternating electric currents at very high rates of alternation and very high voltage, are really endothermic flames of nitrogen and oxygen; in other words, those flaming discharges are simply flames which, instead of giving out heat, absorb heat. Now, in the voltaic arc, as produced in air, something of this kind may occur. There must be a temperature high enough to bring about for the time being the combination of nitrogen and oxygen. We know from Prof. Dewar that such combinations are going on. The question consequently occurred to me whether this had anything to do with the voltage of the arc; and within the last month I have made a number of experiments to put this particular point to the test. A number of experiments were made in my laboratory to test whether the possible combustion of nitrogen and oxygen together had anything to do with the E.M.F.'s there observed. We did this by surrounding the arc by a glass tube, into which we could introduce a number of gases, say oxygen, nitrogen, carbonic dioxide, hydrogen, and so forth. Using always short arcs, and waiting until the current was adjusted to 10 amperes and the arc adjusted to the exact length, we found it does not really make one volt difference. The back E.M.F., or whatever it is, is independent of the surrounding atmosphere.

Incidentally we have observed several effects—namely, that when chlorine and carbonic oxide are used as the atmosphere in which to produce the arc, the crater takes a quite different form from that of the usual arc. The carbon is flattened over the end instead of hollowed, and the negative carbon is also a very obtuse cone. Also when the arc is made with hydrocarbon or coal gas around it the crater is formed, but the edges do not burn away as they do when the arc is made in air. Consequently, there is a regular sooty deposit all round, and the arc is formed up inside a sort of cage. When the arc is made in oxygen both the carbons burn away very fast. Instead of their ordinary consumption there is an extraordinary consumption, which burns them down conically a long way. We have also observed in bringing these gases to the outside of the arc it is necessary that they be introduced gently, without violent draughts, because with even a gentle current of gas the voltage is altered. By blowing on an ordinary arc in air the voltage has been made to rise to as much as 75 volts.

The experiments were conducted by Mr. Eustace Thomas, one of the demonstrators, and by Mr. Portheim, one of my students, to both of whom my thanks are given. There still remains much to do in measuring with exactitude the small variations which may be due to endothermic actions

PORTABLE ACCUMULATORS FOR STAGE EFFECTS.

In the early part of this year we had occasion to notice in these pages some novel electrical effects as shown in the Crystal Palace pantomime, "The Forty Thieves." Recently we have had an opportunity of seeing a further development in this direction in the Crystal Palace ballet, "Little Red Riding Hood."

FIG. 1.—Electric Head Dress.—Back View.

FIG. 2.—Electric Head Dress.—Front View.

It is well known that Mr. Oscar Barrett, the able and energetic manager of the Crystal Palace Theatre, is one of the pioneers of electric lighting for stage purposes. Owing to the pronounced success achieved by the Lithanode Company's batteries at Christmas, Mr. Barrett was encouraged to still further extend their use in his summer production. As a result, a series of charming and beautiful effects have been produced.

A number of ladies in this exceedingly pretty ballet have been supplied with small lithanode accumulators and lamps. As shown in Fig. 1, the batteries are dropped into a small satchel which is securely fixed to the dress. Two silk-covered flexible wires serve to carry the current up to a small four-volt lamp, which is held by spring terminals. The battery used is small and compact, and weighs about a pound. The incandescent lamp is fixed in the centre of a bright metal star with radiating arms, as represented in

Fig. 2. Forked terminals fixed on the ends of the connecting wires serve to complete the circuit between lamp and battery, and these afford a method of instantaneously throwing the lamp in or out of action. The small glow lamp requires from 0·6 to 0·8 amperes and four volts to fully light it. Each cell has a capacity of 1·5 ampere-hours, a capacity quite outside the maximum requirements of the performance. The battery consist of two cells, which are mounted in a thin metallic containing case.

A special feature in these batteries is the precaution taken to prevent any possibility of leakage of the electrolyte, the escape of which has unfortunately been the great drawback to the employment of all forms of batteries for personal or stage decoration, and, as a consequence, although 39 of these batteries have been used at each of the 100 performances given, no accident or damage of any kind arising from this cause has occurred.

Viewed from the front, the effect of the electric lamps is most charming. Each little lamp appears to emit rays much in the same way as a veritable star, and the light reflected from the bright metal background darts about in every direction. It seems almost incredible that such a brilliant effect can be produced from so minute a source of light. A casual onlooker would be inclined to judge the lamps as being from 3 c.p. to 4 c.p., but this enhanced effect is doubtless due to the contrast between the electric light, which is nearly white, and the yellow gas light which forms the background.

In addition to the light shown in Figs. 1 and 2, other novel electric effects have been introduced. In one of the scenes the indispensable "good fairy" is supposed to descend from the clouds to earth, and being somewhat electrical she naturally makes for the nearest and most prominent point, which in this case happens to be a hollow tree. In this piece of stage property the lady is supposed to secrete herself, and she ultimately emerges just in time to frustrate the designs of the wicked fairy. How to produce a halo around the fairy-like form while enclosed within the tree was a problem which could not readily be solved by the employment of the ordinary illuminants; but Mr. Barrett seems to have successfully overcome this difficulty by introducing the electric light. To this end a number of small incandescent lamps are fixed within the tree, and these being backed by reflectors cast their light upon the figure as soon as the current is switched on. This arrang ment is shown in Fig. 3.

Fig. 3. Electrical Effect in Hollow Tree.

In the hut scene, which piece of apparatus is push bodily on to the stage, a glowing fire is represente Under ordinary conditions the fire would be produced b gas jets, which are exceedingly unsafe and not altogethe suitable. Here again, however, electricity is called in, an a few small glow lamps worked from a battery, which fixed to the scenery and goes on with it, gives the desir result.

From time to time during the summer months dramat performances are given at the Crystal Palace. On th occasion of the visit of "Niobe" from the Strand Theatr the management were somewhat at a loss to produce th electrical sparking which is supposed to bring Niobe life.

This difficulty, we are told, was soon overcome by utilisi some of the small lithanode cells to produce a flashing ar which piece of apparatus was fixed at the base of th figure. Again, a similar effect was produced on the visit Mr. Arthur Roberts with his "Two Lovely Black-Ey Susan" company. In this case an electric lamp wa placed in the lighthouse, and was made to appear a vanish at the will of Mr. Roberts, much to the amuseme of the audience.

Doubtless the success of the lighting we have just describ is due to the fact that the whole arrangement was plac in the hands of the Lithanode and General Electric Co pany, they on their part undertaking the recharging a maintenance at a stated charge per lamp per week.

We have probably said enough to show the enormo possibilities for both fixed and portable electric lig when used for stage lighting. It certainly does se somewhat strange that hitherto so very little should ha been done in this direction. A light so safe and eas managed, and capable of so many applications, must sure supersede all others at no very distant period. We a pleased to see theatrical managers co-operating with el trical engineers in the way that Mr. Barrett and the Lith node Company seem to have done. We believe that l affording each other assistance to their mutual benefit ma beautiful, safe, and original lighting effects could be p duced on the stage which would come as a great a pleasant surprise to many of us.

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CONTENTS.

TO CORRESPONDENTS.

LOOKING FORWARD.

It was Tennyson who sung in "Locksley Hall"—

"When I dipt into the future far as human eye could see,
Saw the vision of the world and all the wonder that would be."

and descending from song to story, it was the able engineer to the Kensington Vestry who, at the meeting of Municipal Engineers, as a section of the Sanitary Institute, jocularly remarked to his fellow-members that Kensington was looking forward to inaugurate the time when dust-bins would be emptied by electrical means. You press a button and electricity will do the rest, was his refrain. That good time coming is still "the vision of the world," but the idea is not so far-fetched as some of those present seemed to think it to be. Mr. Weaver alluded to the 'buses and parcels-carts that are driven by means of a secondary battery, and seemed to think that secondary batteries might possibly take the place of horses in dust-carts. We have no great faith in progress in that direction, but if the mind of the electrical engineer is allowed full play it is easy to see how great a share electricity may play in many necessary municipal operations. Assume that electric lighting becomes general. There will then at every house or every lamppost be terminals that are within easy reach for whatever service may be required. For the moment restrict the outlook to dust-carts and drain gullies. There is little difficulty in designing a cart to be driven by a motor, the motor also being able to be used for other purposes, such as winding a drum connected to a pulley. Imagine, then, the household refuse collected in a pattern receptacle, and placed in certain well-defined positions ready for the collector. The collecting cart could be driven by a motor obtaining current from street lamp terminals or other terminals suitably placed. When it was necessary to lift the refuse the cart would be standing still, and the pulley could be attached to the motor, the refuse lifted as high as required and tipped into the cart. The pulley would be switched off and the cart be switched on, and so on through the whole round. If an electric tram line existed, the work would be still further simplified, especially where overhead wires could be tolerated. Admit that the idea is merely a stretch of the imagination, at the same time it must be admitted that it is perfectly feasible, and that the simplification of details would make it commercially practicable. A reel with a hundred yards or so of flexible armoured wire, with plugs to make contacts at the lamppost or other terminals, and with the motor brushes, would be no very weighty apparatus, and would run the cart from lamppost to lamppost, even when more than the average distance apart. As for the street gullies, it is advisable not to let the solid detritus from the streets get into the drains, and so traps are used to contain the solids, while the water itself runs over into the drain. Mr. Bennett, the engineer to the Southampton Corporation, has devised gully traps to be raised by hydraulic pressure, or by compressed air. We have seen the arrangement and know how admirably it can be made to work and what a great saving is effected

thereby, but it seemed to us that the properly-designed cart with its motor and pulley could lift the trap just as well as the water or the compressed air, and with electricity generally in use would probably be a much less costly process than either the hydraulic or compressed air. Thus, while we agree with Mr. Weaver that there is nothing outrageous in his idea—even though he might not have put forward that idea seriously, but rather as a means of turning the laugh against the advocates of the inexhaustible mine of steam development to be got from destructor work—we do not go with him in the use of secondary batteries, but prefer to "dip into the future" and foresee the development of the motor. We take it that, though speaking jocularly, Mr. Weaver had serious thoughts behind, for the remarks arose during the discussion on a paper by Mr. Jones, of Ealing, upon refuse destructors. The reader of the paper, and the various speakers, seemed to think that properly-constructed destructors in most districts would enable the authorities to obtain sufficient heat to generate a considerable quantity of steam, and that this steam might be used in a variety of ways—among others, to drive engines and dynamos. Indeed, in various towns electric light is even now so obtained, as at Southampton, where Mr. Bennett has a considerable installation. Further, if, as Mr. Mawbey, of Leicester, says, a greater quantity of heat can be obtained by the use of movable bars and other modifications, this excess of heat may lead to more steam being available, till Prof. G. Forbes's anticipation is realised, and the refuse of a household is found sufficient to generate the artificial light it requires.

THE SEARCH-LIGHT AND NIGHT FIGHTING.

When the arc lamp and the dynamo became practical, a modification of the former was soon introduced as a search-light for naval purposes. Now all ships of war and most of the large vessels of commerce are fitted both with search-lights and with electric light generally. The field telegraph is an important auxiliary in all land operations, and now experiments are being inaugurated to obtain information as to the value of movable search-lights for night attack, for the use of fixed search-lights is not so new. The successful use of movable search-lights for military purposes is no easy task, but no doubt in many instances will amply repay all trouble. It has been left for Lieut.-Colonel Tully, 4th V.B. East Surrey Regiment, in conjunction with Captain Ronald Scott, 4th Middlesex Rifles, to attempt experiments in night attack and defence aided by search-lights. Captain Ronald Scott, whose experience with search-lights is very extensive, supplied the electrical equipment, using accumulators to work the search-lights rather than a dynamo. This seems the correct plan, because the object is to remain hidden whilst the enemy is exposed. A dynamo means a portable engine, but the accumulators mean nothing more than waggons and horses. It is impossible for us to enter into the details of the sham fight which was carried out on Wimbledon Common, but it is absolutely certain that valuable experience in the use of the search-light was gained. At first, instead of showing the enemy and hiding themselves, the use of the light produced the contrary effect, but Captain Scott, grasping the situation, took the management of the light into his own hands, and thenceforth obtained the effect desired, with the result thus described in the *Daily Graphic*: "When the foe did appear, therefore, they were ready to meet him with effective volleys, which seemed to leap out suddenly from the wall of night; and directly the attacking skirmishers halted, the search-light began to play a dazzling ripple along their line from end to end, now flashing in one man's eyes and then in another's, so that not only were they seen clearly from our side, but their aim must have been baffled completely. When they began to advance again the light was flashed in their eyes again, so that had there been irregularities of ground marching without mishaps would have been impossible." We have no doubt this successful experiment will lead to a more extended series, so that the correct use and true value of such a movable light for night operations may be determined.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

HISTORY OF LIGHT AND POWER.

SIR,—I feel sure your numerous readers cannot fail to read with pleasure any historical work or comments which may bring to light the evolution of electrical engineering and the historical work of ancient electricians, but as all such works to be of real value to future generations should be based upon solid and indisputable facts relating to the matters in question, under these circumstances I feel sure Mr. Arthur F. Guy will forgive me calling attention to one or two errors which have crept into his articles. First, Mr. Guy fixes the adventual year of the evolution of electric lighting as 1810. Now, I think I am right in suggesting that this should be fixed as the year 1809 instead of 1810, especially as the first practical experiments relating to the production of electric light were carried out, not by Sir Humphrey Davy himself, but by Dr. Wollaston, Sir E. Horne, and Mr. Children, the designer of the Cruikshank-Children battery, as used for the experimental work carried out at the Royal Institution, in conjunction with Prof. Brande, the secretary of the above institution. Sir Humphrey, 'tis quite true, greatly improved upon the earlier experiments of the above in the year 1810 by using a battery of greater intensity and by adopting charcoal rods enclosed in an exhausted globe filled with chlorine gas. Hence more brilliant effects were obtained by him than from the experiments of earlier workers, many of whom, both in England and abroad, were working upon various methods for the production of the new light, and whose names should not be allowed to be buried in oblivion; hence my object in calling attention to some of the work carried out at the early part of the present century, and also prior to Sir Humphrey Davy. I may say I have no desire to underrate the grand work of Sir Humphrey, but simply to bring to light the work of his associates, and other inventors at this early period, who were all deeply absorbed in solving the long-looked-for problem—viz., "the production of electric light"—many of whom deserve great credit for the various contributions and experiments brought to light by them between the years 1803 and 1810. Amongst them I think should be coupled the name of Ritter, whose early and successful experiments on battery work and the storage of electricity is, perhaps, one of the most interesting

in these modern times. His early work is clearly described in Izarus's "Manual de Galvansme," and other French journals published between the years 1803 and 1806. Ritter was apparently one of the foremost electricians of his time, and I have no hesitation in saying, according to Izarus's descriptions of Ritter's work, that to this savant the credit is due of having constructed the first secondary battery known to science, and whose early work and experiments on storage and polarisation batteries gave Nobile, Brugnaletti, Zamboni, Becquerel, Marianini, Joule, De la Rive, Planté, Kirchhof, Niaudet, and other early workers of the more ancient school, also the work of more recent inventors, such as Percival, Faure, Woodward, Brush, Swan, and others belonging to the modern school, whose combined improvements have resulted in reliable batteries; but at the same time, the fundamental and ground work upon which the secondary battery industry has been immortalised certainly descended from the fundamental principles and pioneer work carried out by Ritter, and to him the credit of this invention should be awarded. Moreover, I fail to see how Sir Humphrey Davy could have used a "Grove battery," as suggested by Mr Guy, which battery, if my memory serves me rightly, was not invented until about the year 1839. Probably the battery used by Sir Humphrey would either be a Ritter, Cruikshank Children, or Wilkinson type, as these were the only suitable batteries then known to science and in use at the early part of the present century. In order to make his work of real value I should advise Mr Guy to correct it prior to publication, for as all rights are reserved, I presume this is the intention of the compiler of the articles, which have been read with interest by yours, etc.,

ARTHUR SHIPPEY.

Sept. 15, 1892.

MAGNETIC VISCOSITY.

BY J. HOPKINSON, F.R.S., AND B. HOPKINSON.

The experiments herein described were made in the Siemens Laboratory at King's College. The object was to ascertain whether the cyclical change in the magnetic induction in iron due to a given cyclical change in the magnetising force is independent of the speed at which the change is effected—that is, whether any sign of "magnetic viscosity" or "magnetic lag" can be observed when the rate of change is such as is found in transformers. The question is one of much practical interest, and has been much discussed, amongst others, by Prof. Ewing at the recent meeting of the British Association. Prof. Ewing has devised apparatus adapted to deal with this matter as well as for drawing curves of magnetisation.

We have experimented on two materials. One was soft iron and the other a hard steel containing about 0.6 per cent. of carbon. Both samples were supplied by Messrs. Richard Johnson.

It had been found, in experiments on ordinary transformers, that the local currents in the iron made it impossible to form a correct estimate of the magnetising force. The effect of such local currents can, of course, be diminished by using finer wire or plates and better insulation. Our material was in the form of wire $\frac{1}{100}$in. diameter, and the wire was varnished with shellac to ensure insulation. It was wound into a ring having a sectional area of 1.04 square centimetres in the case of soft iron, and 1.08 square centimetres in the case of hard steel, and about nine centimetres in diameter. The ring was wound with about 200 turns of copper wire, and with a fine wire for use with the ballistic galvanometer. An inspection of the curves showing the results will satisfy the reader that the effects of local currents were negligible.

For determining the points on the closed curve of magnetisation, given by rapid reversals of the current in the coil, the ring was connected in series with a non-inductive resistance to the poles of an alternate-current generator or a transformer excited by the generator (see preceding column), in which A B are the poles of the transformer or generator, C D the terminals of the non-inductive resistance R, H the coil surrounding the ring, P and Q the studs of a reversing

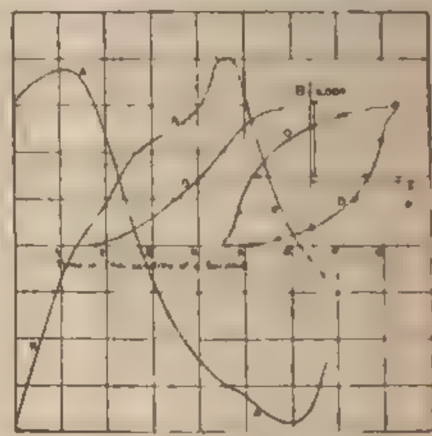


FIG. 1.—Soft Iron. Frequency 103.

key connected to the quadrant of a Thomson quadrant electrometer, L a key, by means of which Q could be connected with C or E at will, and K a revolving contact maker through which P was connected to D. A condenser was connected to P and Q in order to steady the electrometer readings. The contact maker, K, was bolted on to

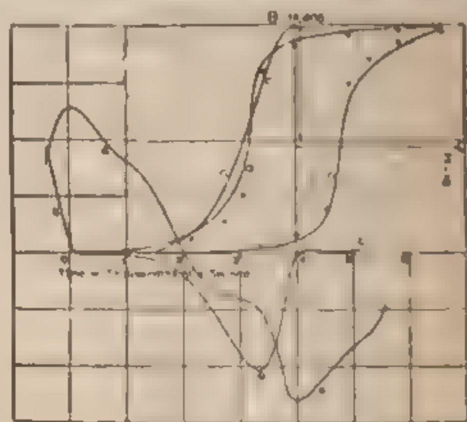


FIG. 2.—Soft Iron.

the axle of the generator. It consists of a circular disc of ebonite, about 13in. in diameter, having a small slip of copper about $\frac{3}{16}$in. wide let into its circumference. A small steel brush presses on the circumference and makes contact with the piece of copper once in every revolution. The position of the brush can be read

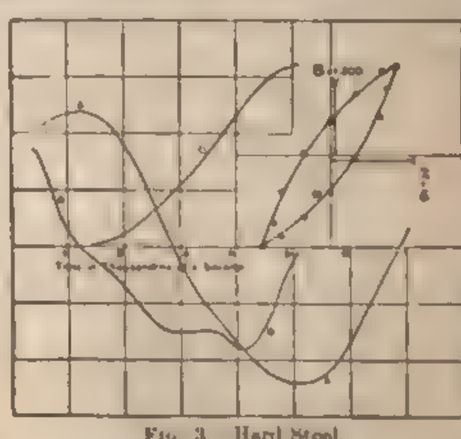


FIG. 3. Hard Steel.

off on a graduated circle, and thus contact can be made at any desired instant in the revolution, and that instant determined by means of the graduated circle. The quadrant electrometer thus gives the instantaneous value of the difference of potential between the points C and D, or the points D and E, according to the direction of the

key L. The frequency was in all cases, except one, 125 complete periods per second. From observations of the values of the potential difference between C and D at different times in the period, a curve (A) was plotted giving the current or magnetising force in terms of the time; a similar curve (B) was plotted for the E.M.F. between D and E. The curve (B) corrected by subtracting

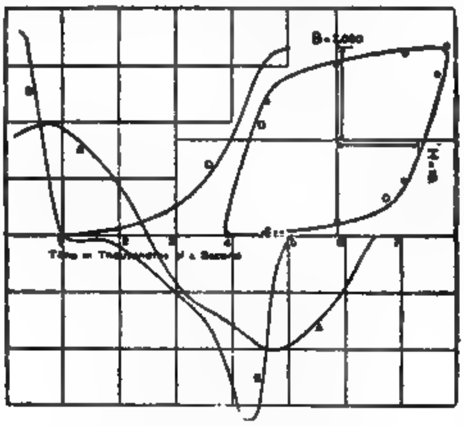


FIG. 4.—Hard Steel.

the E.M.F. due to the resistance of the coil H gives the potential or time rate of variation of the induction in terms of the time. Hence the area of B up to any point plus a constant, is proportional to the induction corresponding to that point. This is shown in curve C, which is the

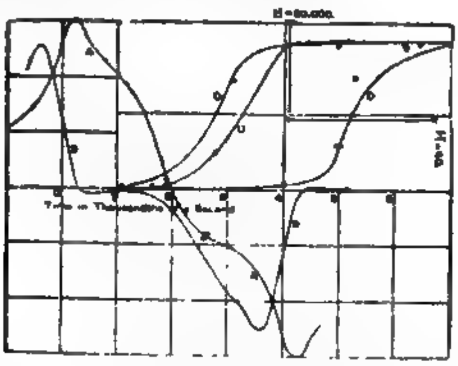


FIG. 5.—Hard Steel.

integral of B. A fourth curve (D) was then plotted, in which the abscissa of any point is proportional to the magnetising force at any time (got from curve A), and the ordinate is proportional to the induction at the same time (got from curve C).

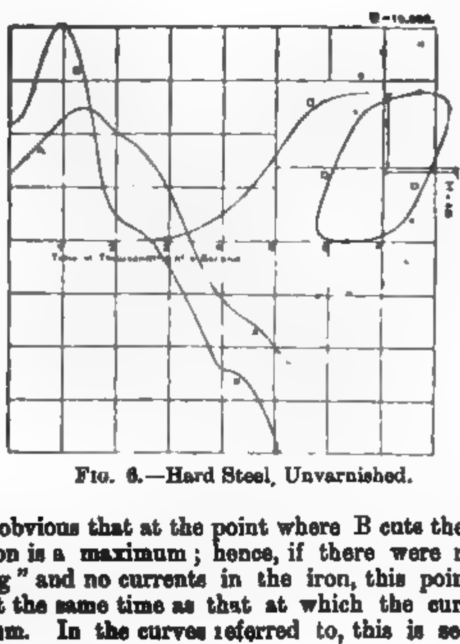


FIG. 6.—Hard Steel, Unvarnished.

It is obvious that at the point where B cuts the axis the induction is a maximum; hence, if there were no "magnetic lag" and no currents in the iron, this point should occur at the same time as that at which the current is a maximum. In the curves referred to, this is seen to be nearly the case.

The slow cycles were obtained from the ballistic galvanometer, by observing the throw due to a known sudden change in the magnetic force. Care was taken always to take the material through the same cycle. The points got by the slow method are in each case shown in absolute measure on the same scale as that to which the quick curves are drawn, and are indicated by black dots; they are hardly numerous enough to draw a curve with certainty, but are ample to exhibit the identity of or the character of the difference, if any, between the curves, as determined by the two methods.

Figs. 1 and 2 show the results of experiments on soft iron, Figs. 3, 4, and 5 were obtained from the hard steel. In all these the agreement between the slow and rapid cycles is fairly close. Fig. 6 is interesting, as showing the large effect of local currents. It was obtained from the same sample of steel wire as Figs. 3, 4, and 5, but the wire was not varnished. It will be seen that the maximum induction lags behind the maximum magnetising force about one-sixth of a complete period, and also that the maximum induction attained is but 10,000 as against 17,200 obtained from the same (apparent) magnetising force by the slow method.

Hence the general result is that up to the frequency tried—*i.e.*, about 125 per second—there is no sign of magnetic viscosity; the magnetic cycle is unaffected by the frequency so far as the maximum induction for a given magnetising force is concerned, but that there is a sensible difference between the curve as determined by the two methods, most apparent in that part of the curve preceding the maximum induction. This difference is well shown in Fig. 5. We have not yet fully investigated this feature; possibly it arises from something peculiar to experiments with the ballistic galvanometer.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.*

BY PROF. GEORGE FORBES.

LECTURE I.

(Continued from page 268.)

The Northampton Electric Light and Power Company have equal weights of distributing mains and feeders. The capital invested in mains is 42 per cent. of the total capital of the company, the length of mains 2,800 yards, including 350 yards of feeders only, and the total weight of copper 16 tons. The mains consist of bare copper in Crompton culverts, where possible; Henley's A A cable in 2in. iron pipes at road crossings, etc.; Fowler-Waring cables, lead-covered, laid in half glazed-pipes with sand, and covered with concrete, and Callender cables in iron troughs and bitumen, for isolated feeders. The average cost of mains is 45s. per yard. The indicated horse-power at work is 240; 120 additional being on order. The number of 8-c.p. lamps supplied, 33,000. The proportionate cost of buildings and machinery, etc., to paid-up capital is—building and machinery, 46 per cent.; land, 5 per cent.; the paid-up capital being £15,000.

Another company, with paid-up shares and debentures = £73,585, whose expediture on mains is £17,440, has 20 miles of cable in six miles of streets, consisting of 20½ tons of copper for feeders, and 28 for distributing mains. Actual cost of supplying and laying Callender-Webber casing with three 2in. ways, including all charges, with straightforward work = 6s. 6d. per yard, or including the draw and service-boxes, 8s. 9d. per yard run. The lamps = 28,000 of 8 c.p., and there is 830 h.p. in the central station in the shape of steam engines alone.

The Allgemeine Elektricitäts Gesellschaft has over 700,000 metres of copper, weighing 1,500 tons, nearly all in Siemens armoured cable, costing from £2 to £4. 10s. per yard. This enormous mass of copper accounts for the splendidly constant pressure always maintained in the network.

The Secteur Clichy, in Paris, cover 26 kilometres of street with 31 kilometres of feeders and 121 of distributing mains.

* Cantor Lectures delivered before the Society of Arts.

The cost of laying 3in. iron pipes in cement in New York, with manholes 7ft. deep, 8½ft. square inside, with 12in. walls of brick in cement, depends on the number of ducts, and is as follows

No. of ducts.	Dollars per duct per foot run.	Shillings per yard.
2	1·91	23·92
4	1·11	—
6	·85	—
8	·71	—
10	·63	7·56
12	·58	—
14	·54	—
16	·51	—
18	·49	—
20	·47	2·4
24	·44	—
30	·41	—

The average cost of a house connection, from a large number of actual cases is 66·02dol., say £13.

These special cases are given as a small contribution to the general question. My own general experience is that mains ought to cost, on the low tension system, about half the capital of the company, about equally divided in distributing mains and feeders. I think that far more copper would be put down in mains if people realised the low rate of interest at which money could be raised in debentures on them.

Experience is the best guide as to the proportion between feeders and network mains. The smaller the latter, the more numerous must the former be. The distance that can be covered by a feeder depends on many things, but firstly on the variation in pressure allowed at the house connections. The Board of Trade, wisely I think, has given great latitude, four volts either above or below the normal 100 volts—*i.e.*, an 8 per cent. variation—but it is to be hoped that supply companies will find it to their interest to attain a higher standard. If the feeder point is kept at a constant pressure of 100 volts, the four volts will be lost in 80 yards if the section of copper is based upon a current density of 1,000 amperes per square inch, or in 240 yards if 330 amperes per square inch is chosen; and I am glad to say that in this country a large section like this is recognised as the best design. If now we use a three-wire system, we can go to twice the distance—or 480 yards—with a current density of 330, still with a maximum drop of four volts. If the pilot wires which indicate pressure be not at each feeding point, but half-way to the most distant lamps supplied by a feeder, the length of main which can be fed is again twice as great, or 960 yards, the lamps at the feeding points varying from 100 volts at times of small demand, to 104 at the maximum, the lamps at the distant end varying from 100 volts at times of small demand, to 96 at the maximum. If now the lamps at the feeding points be 104-volt lamps, and those at the distant end 96-volt lamps, with graduated voltages at intermediate points, we can increase the length of main supplied by a feeder to 1,920 yards, and no lamp will have a greater variation than four volts above or below its normal value. Of course, this result has never been attained in practice, because in most cases it is difficult to accomplish. I do not generally approve of using lamps of different voltage on a circuit. The only time I ever sanctioned it was when I settled what was to be done by the St. James's and Pall-mall Company. Here the district was so compact that I could see easily that we would not be bothered by the future extensions. There is also some trouble in putting the pilot wires in the place indicated. There is also some difficulty in arranging the feeders so that they all feed into the network at the required pressure. Some engineers are also afraid of the three wire system, having had no experience of its use. And, again, in a badly-fitted station, it is difficult to ensure that the engines are working quite uniformly, so that a 2 per cent. variation, up and down, may be all that can be calculated for in order to conform with the Board of Trade requirements. All these reasons may reduce the workable distance, even when the low-current density here assumed is taken, from the above 1,920 yards down to 240 yards. I wish to impress strongly on you the fact that there are four distinct methods of improving the distribution—(1) increasing the regularity of the engines, (2) using the three-wire system, (3) putting the pilot-wire connections halfway between feeder points, and (4) varying the voltage of lamps according to the distance from a feeder point. The last is the only one which cannot be safely done in all cases, and each of these four remedies enables us to go to double the distance, the introduction of the three-wires being the only one which increases the weight of copper a little; or we may say, especially with relation to the position of the pilot wires and the voltage of lamps, that these remedies each halve the weight and cost of copper in the mains, and, combined, reduce it to one-quarter. The practical objection to using lamps of different voltages is that generally the network is first laid down and the feeders added in greater number as the demand increases, hence the voltage of lamps in any house will be changed. But the improvement on existing methods which I have advocated, of putting the pilot wire attachment half way between feeder points, saves half the copper, and can always be applied.

Management of Feeders.

In the central station the arrangements for supplying the feeding points with the same pressure are not always satisfactory. It has been customary in many cases to make the resistance of each feeder the same, so that when the same current is flowing in each the fall of pressure along the feeder is the same. Other people use adjustable resistances to regulate the pressure. In both these cases omnibus bars can be used to connect all the dynamos in parallel and all the feeders in parallel. This is very wasteful. Another plan is to use the dynamos at different pressures, and group the feeders on them according to their requirements. This is perfect in theory, but difficult in practice. It involves frequent shifting of a feeder from one dynamo to another, and it involves engines running at low loads. Another plan has been suggested, to put in a few secondary battery cells in the feeders in place of resistances, some to raise and others to lower the pressure according as they assist or oppose the current. The two volts given by such cells is a convenient unit for such a purpose. The best plan seems to me to be one which has not hitherto been adopted. Connect all the dynamos in parallel on omnibus bars. Between this and the feeders put switches, by means of which one or more low tension dynamos (of two volts, say) can be switched in to assist or oppose the current. I would not suggest this were I not now thoroughly satisfied with the low tension non commutating dynamos with which my name has been connected. To show their suitability, I will merely record an experiment with one of these dynamos used with a Parsons steam turbine. The armature was merely a solid bar of wrought iron, 3in. in diameter, and it rotated between two magnet poles, which enclosed it, at a speed of 24,000 revolutions a minute. With this we welded pieces of iron ⅝in. diameter, and then heated a rod of ⅛in. iron, 15in. long, to a white heat for an hour and a half, and everything was working quite smoothly, and could have gone on like that for 24 hours. The E.M.F. on open circuit was four volts, and on closed circuit two volts.

Loss in House Wiring.

I hope that before long the Board of Trade will reduce the variation now allowed of 4 per cent. up and down to half this amount. There is always a certain loss of pressure in the house wiring, which ought never to exceed two volts. But as householders seldom engage an electrical engineer to protect their interests against the contractors, the latter generally use thinner wires than is right, and so reduce the pressure in the lamps still more. A variation of more than 2 per cent. from the normal pressure at the lamps is very objectionable in practice, though I suppose we must put up with it for some time.

Recording Voltmeters.

I will now show you some results of actual work. I have on the table one of the recording voltmeters made by Messrs. Richard Frères. It is like the well known recording aneroids. A cylinder is revolved by clockwork and carries a ruled sheet of paper, while the paper travels horizontally, a voltmeter causes a pointer filled with ink, and just touching the paper, to rise and fall with the electric

pressure, and thus we get a continuous record of the pressure which a house is receiving from the supply company. This instrument is very convenient and useful. The one I have been using is made to work up to 120 volts, and its range of greatest accuracy is at half this pressure. The controlling force of the magnet is weak at 100 volts, and the friction of the paper comes into play to diminish the actual irregularities. Still, I have been able to obtain

FIG. 2.

interesting curves in a variety of places, and I wish to draw the attention of administrative bodies like the London County Council to the necessity of using such instruments in the interests of the community, and as the only real check upon the supply companies. The instrument which I have used reads low at 100 volts. I have a number of curves taken at four places on the mains of one supply company, and except at one place they come out very nicely, only we must remember that the full irregularities

FIG. 3.

are not shown by this instrument. The places of which records are shown are my office, at 34, Great George-street, 39, Victoria-street, 13, Ashley-gardens, and the Scottish Club in Dover-street, Piccadilly. (Some of these curves are here reproduced. Figs. 2 and 3 are records taken at my office in Great George-street; Fig. 4, one taken at the Scottish Club; and Fig. 5, one from Ashley-gardens.) To show the real irregularities, I have added drawings from actual observations at frequent intervals of an accurate

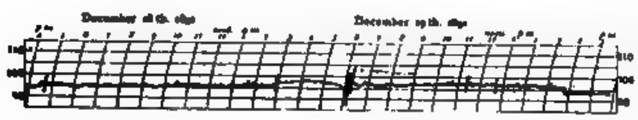


FIG. 4.

voltmeter, when you see, Fig. 6, that the pressure in my office is always high, and sometimes reaches 109 instead of 100 volts. Of course this is very destructive to the lamps, and renders the company liable to fine. The pressure at this part of the distribution system is always too high, and apt to injure the lamps. At Dover-street, on the other hand, the pressure is always too low, and the illumination is bad. When the busy evening hours come on, the pressure at Dover-street always falls. The influence of a

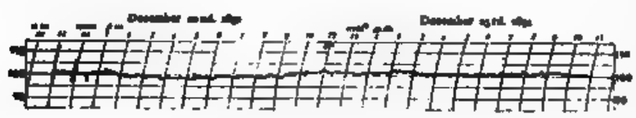


FIG. 5.

fog is shown in the same way. It is not to the interest of a supply company that such defects should go on. While exhibiting these curves, I had one taken at the Athenæum Club, Fig. 7, which is supplied by a gas engine and dynamo of its own, with accumulators as regulators, and for use during slack hours. Notice the violent irregularities, simply owing to the carelessness of the attendant, and also notice the effect of the pulsations of the gas engine, showing a pulsation of two or three volts, which goes on every second or half second, and is most trying to the eyes.

FIVE-WIRE SYSTEM.

The evident advantages of the three-wire system can obviously be extended to a greater number of wires, if we do not object to bringing the higher electric pressure into our houses and up to the lamps. This has been done with five wires, by the company lighting the Secteur Clichy at Paris, and in other places. Since five wires here take the place of eight, the advantage is greater than when three wires take the place of four. By using it we can also go to twice the distance of the three-wire system. I shall have something to say about this method in my next lecture, to which it is more suitable.

BATTERIES.

I must conclude this part of my subject with some mention of a class of electrical apparatus which has been improved more than anything else in connection with low-

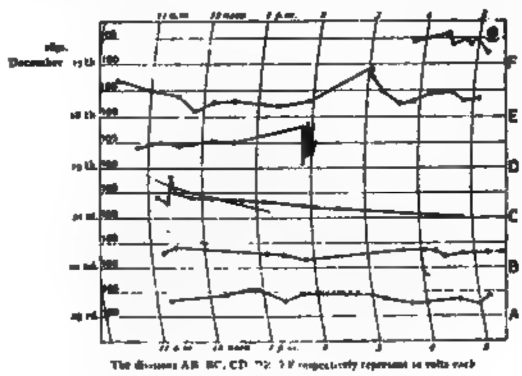


FIG. 6.

pressure supply since I gave my previous Cantor lectures. The position which I then took up was this, that there was no plan for electric lighting so satisfactory as the secondary battery plan, but it was hopeless to think of it until one important element was invented—namely, a practical secondary battery. That *desideratum* is much nearer realisation. In the last 10 years dynamos have been much improved, and so have lamps, but in no branch has the improvement equalled that in secondary batteries.

These improvements are partly in the way of making the plates more substantial, and less liable to buckle or scale, or for the pellets to drop out, and partly in their management, the chief step in the latter direction coming from the discovery that batteries will stand any amount of overcharging, and really improve in the process, and also that they should never be allowed to run down, and that low specific gravity should be remedied by persistent overcharging, recourse to adding acid being only resorted to at rare intervals. To keep batteries in a high state of preservation in this way involves great expense from the

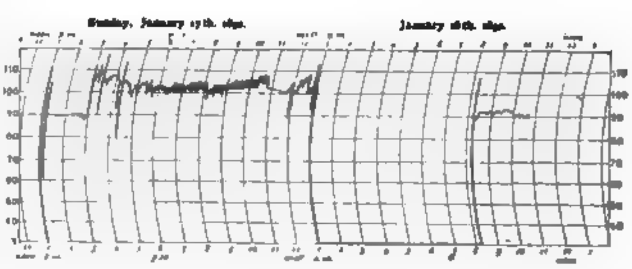


FIG. 7.

frequent overcharging, and also from the fact that, if we never take much out of the battery, we must have a larger outlay in them to do our work. At the present time the only objection to batteries is their expense, and that is now far less serious than six years ago, when their life was very short. Secondary batteries are often called accumulators, or storage batteries, according to the purpose for which they are wanted. They are used for five different purposes: (1) As regulators; (2) to replace dynamos, and give workmen a rest at idle hours; (3) to add to the total output of a central station at a time of maximum demand; (4) as a reserve in case of breakdown; and (5) to transform down from high pressure in the streets to low pressure in the houses. All these are most useful purposes,

and seem so desirable that many companies have adopted them even at a greater cost of supplying the electricity.

Of course, you will always find the manufacturers of any such special plant saying that it does not increase the cost to use it, and when, as often happens, the manufacturer acts also as consulting engineer, you may expect the use of such plant to be more extensive than their costliness warrants. This has been the case in England in many cases, but it is not to be regretted by the general public, because these cases have given us much valuable experience. In this year, 1892, however, the improvements in storage batteries are such that it hardly costs anything more to use them than to do without them, and we see the desirability for storage of some kind in our central stations so much in actual working, that we may hope the time will soon come when some kind of storage will be possible for a large part of our generating plant, so that we will not require to fire up a lot of boilers just for a few hours' work. When a battery is put across the mains at the central station it acts as a regulator, and keeps the current steady in spite of irregularities in the engine. This ought not to be an important point in central stations, but it is in isolated plant worked by a gas engine. The battery in the central station, however, offers a splendid means of regulating the pressure in the feeders, which can then be supplied at any pressure with current, and the size of copper can then be chosen to fulfil the economical law of being proportioned to the current, and not to the barbarous law of making the resistance of all feeders equal. Much discussion has arisen about the value of accumulators in central stations, but it is remarkable that, up to the present time, the one great advantage has been overlooked, which is that you can use them in shunt on the mains as a means of regulating the pressure supplied to feeders. This action is the only solution that has been tried which gives perfect satisfaction. I do not believe that the introduction of accumulators into a central station has ever introduced economy, but in many ways it leads to a better service, and in no way more than in this which I have just indicated. So much is this the case that, except in the few cases where economy overrides quality of light, or in some cases where a fall of water is the source of power, I do not think that any low tension continuous-current central station on a large scale is complete without a small supply of accumulators. The other use of accumulators as transformers of high pressure into low pressure belongs to the subject of my next lecture.

LECTURE II.

In my last lecture I urged the importance of not slurring over the actual difficulties that are before us. We are looking at the question of distribution from an engineering point of view, and it is desirable always to face the difficulties and see our way as far as possible, rather than to slur them over and pretend that they do not exist. Now, I pointed out the chief causes of excessive expenditure in electrical distribution through towns. They are two—first, the cost of distribution; second, the cost of generation. In both of these cases of production and distribution the expense is greater than it would be if we were producing it for our own purpose at a constant rate. Distribution is particularly expensive at the present moment, because there is only a small number of houses connected. Mains are being laid through great lengths of street, and perhaps only one in 30 houses is taking current. That will mend as time goes on, and that cause of excessive cost will diminish in consequence. The other great source of expenditure that any supply company has to face lies in the fact that electricity is not wanted uniformly throughout the 24 hours. This is, perhaps, the most important point to which attention has been drawn of late years in the question of distribution. It injures us in two distinct ways—first, through our engines; secondly, through our boilers.

Owing to the fluctuating demand for light, we are compelled to vary the number of engines which are working to supply the mains, and employ the engines sometimes at below their economical load, and that is extravagant. Besides this, the boilers consume more fuel than if a continuous supply is given, because so much coal is spent in heating them up in the evening. With regard to light loads of engines, few people realise what enormous loss there is when we are running powerful engines at light loads, more especially compound engines. It is quite possible that a 100 h.p. engine, which would be consuming, say, 22lb. of water or steam per indicated horse-power per hour when running at full load would, running at light load—1 h.p. or 2 h.p.—be consuming as much as 600lb. of steam per horse-power hour. This great source of loss could be got over by having the units in the way of engines tolerably small. The smallest size of engine is efficient, so that by employing a number of them, and putting them on in turn, we never have much loss through under loading; but with respect to boilers, we are without remedy at the present time. Great attention was drawn to this point in the paper read by Mr. Crompton before the Institution of Civil Engineers last year, in which he introduced the term "load factor." Load factor is a very important thing, but the one peculiar thing about it is that no one knows what it is. Mr. Crompton introduced five distinct definitions of the load factor, each of them giving a totally different meaning to the other cases where the words are used without alluding to what is meant. I will give you a series of definitions, which, I trust, will suffice for the future. I had hoped that Mr. Crompton would have given us an exact definition, but he has failed us in that, and, therefore, I will give you what I think will be sufficient for engineers.

I will draw attention to these diagrams which belong to the Berlin station.* The heavy load lasts only for a few hours. The thick white line indicates the load which is passing out. During the winter months, at about six or eight in the morning, a small peak is shown. There is nothing else till the afternoon, when it rises to its maximum. The same general features prevail throughout the year in the different months, except in the mornings of the summer months, when the demand for current ceases, and in the summer months the height of the peak diminishes, and the number of hours. Similar curves have been taken in many other central stations, and I would refer to a similar set of great value relating to the St. James's and Pall Mall Company's station, which show the same general fluctuations as the Berlin curves. There are two consequences to be noted from this great irregularity in the demand. In the first place, owing to the high peak that we have during winter, we must have a large amount of machinery ready to take part in supplying current; in the summer months a great part is not in use; and during the day, even in winter, a great portion of our machinery is absolutely idle. It is in this way idle for the greater part of the year. In the second place, we have to fire up our boilers during the slack hours, just before the rise, so as to be able to cope with the demand at the busiest hours, which means waste.

That being the general state of things, let us come to actual definitions about "load factors." Mr. Crompton tried to indicate that it was the ratio of the average quantity of electricity to the maximum, but what maximum was to be chosen for the whole year was not defined. I propose to adopt three distinct definitions—the machinery load factor, the current load factor, and the temporary load factor. By the machinery load factor for any period, I mean the ratio of the average current during that period to the maximum current obtainable from the machinery. By the current load factor for any period, I mean the ratio of the average current during that period to the maximum current ever supplied from the station; and by the temporary load factor for any period, I mean the ratio of the average current during that period to the maximum current supplied during that period. If we adopt these three I think they will be sufficient for all our purposes.

(To be continued.)

* These diagrams are published in a paper read by Prof. George Forbes before the Institution of Electrical Engineers, 28th February, 1889, on "Some Electric Lighting Central Stations in Europe, and their Lessons."

MOTORS USED FOR FOG SIGNALS IN THE NORTHERN LIGHTHOUSE SERVICE.*

BY MR. D. A. STEVENSON, M.I.C.E.

The author dwelt upon the necessity of a means of signalling on the coast line during foggy weather, and enforced his statement by details as to the duration of fog in this country. It appeared that the number of hours in Scotland is 395 per annum. The most powerful sound signal in use is the siren, actuated by compressed air. The author described the various motors used for the purpose. The sources of power are motion of the sea by waves and tide, manual labour, clockwork, steam, hot air, gas, and oil engines. After discussing these various methods, the author sums up by expressing his opinion that the best motor for fog signal purposes yet tried is undoubtedly the oil engine. Mr. Stevenson, however, points out that the best sound signals are feeble and unreliable, and it is his opinion that the solution of the problem of warning vessels in times of fog will be found in the method proposed by Mr. C. A. Stevenson, in which an electric cable or conductor is laid down off a coast or dangerous place. This would act on an instrument attached to each vessel, and so give warning of the approach to danger.

The discussion on this paper was opened by Mr. JEREMIAH HEAD, who pointed out the great advantage of the petroleum engine for fog signalling purposes in isolated spots, such as those upon which the installation was usually required. The smaller weight of the material used, compared to the coal and water of the steam engine, and the quickness with which the motor could be started, were dwelt upon by the speaker.

Colonel CUNNINGHAM pointed out that in many lightships there was no sound signal other than a bell. He considered it desirable to introduce an automatic arrangement of some description. He asked the maximum duration of any fog.

Mr. SENNETT said the paper was of particular interest to him, as mention had been made of the probability of some system of electric cable protection being perfected by means of which vessels could be warned of their approach to the land during fog. He had devised a scheme for this purpose and had just commenced experiments. His system was to produce a sound of known pitch beneath instead of above the water; for this purpose an ordinary siren worked by compressed air, and having independent motion imparted to it, so that it would emit a note of constant pitch, would be suitable. On board the vessel he would arrange an electrical receiving instrument, consisting of a micro-telephonic apparatus tuned in unison with the sound of the warning station. This instrument would be located in a padded cabin, and the officer would listen for the code signal which would give him the name of the station from which the sound emanated. This direction in relation to the course of the ship could be read off by a suitable dial. Mr. Sennett pointed out the great danger in the present system of aerial fog signalling. This was caused by the existence of what Prof Tyndall had termed acoustic clouds, which are in reality strata of air of various temperatures which had the power of refracting the acoustic ray, tilting it upward so that it failed to reach the vessel. Thus, with apparently the same atmospheric conditions, a fog signal which had been heard at one hour of the day at a distance of 10 or 15 miles might not be heard at another hour more than 3 or 5 miles. Mr. Sennett pointed out the fact that the velocity of sound in water was some five times as great as in air, and that the disturbing conditions above mentioned did not exist in the sea. With reference to the communication with lightships, the speaker had devised a system in which the signals were given entirely by induction, so that no material or cable connection between ship and shore was necessary. He had only the River Thames to experiment in, and he would be glad to hear of Mr. Stevenson following the matter up, as he had better facilities for working in the same direction.

Mr DAVID CUNNINGHAM, the Dundee Harbour engineer, said the great advantage of the petroleum engine was that the sound was got directly the fog came on, without waiting to get up steam. They could hear a fog signal for 10 miles under favourable conditions, but the sound was not to be always depended upon for more than a half to a quarter that distance. He had known one case in which a steam yacht had started from the harbour when the siren was in operation, but at the distance of half a mile it could not be heard, although when four miles had been traversed, the sound was again audible.

Mr. WIGHAM said that however good the signals described might be, it was no good for mechanical engineers turning their attention to the matter unless they were adopted. It seemed to him that when a reasonable demand was made by the shipowner to have a danger signal put up, that demand should be attended to, and not refused on the paltry ground of want of money. Two years ago the "City of New York" was within a yard or two of the very rock on which the "City of Chicago" had been recently wrecked. The sudden clearing up of the fog had revealed the danger. At that time the shipowners memorialised for a light to be put on the Old Head of Kinsale, but the request had been refused on the ground of the expense. The speaker considered the gas engine superior to the petroleum engine when gas could be got; in other cases the petroleum engine was best.

Mr. PERRY F. NURSEY gave some very interesting results of his experience with submarine explosions, as bearing upon the conveyance of sound by water.

Mr SENNETT added that Prof Hughes had made experiments in Lake Geneva. An ordinary bell was rung under water, and the sound could be heard a distance of nine miles by the aid of a small speaking tube to convey the sound from the water to the listener's ear. While bathing two stones were knocked together, and at a distance of half a mile the noise was so unpleasant when the head was put under water that the experiment was not repeated.

Mr. C A. STEVENSON, in replying to the discussion for his brother, who was prevented from being present by illness, said that the cost of a first-class installation, such as he had described, was £1,700. The maximum duration of any fog in that district was 80 hours. With regard to the under-water signalling he did not think that the indications would extend for five miles. In the case of a dynamite explosion under water it was not audible at very short distances, whilst it was well known that divers could not hear the firing of guns. It may be pointed out that neither of these cases are analogous to that quoted by Mr. Sennett.

* Paper read before the British Association at Edinburgh.

PRIMARY AND SECONDARY CELLS IN WHICH THE ELECTROLYTE IS A GAS.*

BY PROF. SCHUSTER.

It is well known when you have a discharge passing through a tube the tube thereby becomes a conductor, and you can send a current in any other part of the tube from a Daniell or any other cell through. It seemed to the author that it would be of interest to study the laws of that conduction which he would like to call secondary conduction in gases, because we are evidently having a more simple phenomena than in the other. For this purpose I have a tube with electrodes, then in some other part of the tube there is introduced platinum wires which are connected to ordinary batteries. While refraining from entering into the principles of the laws of secondary discharge, there is one point which is of interest on the theory started by different physicists, that the primary phenomena of discharge depends upon the dissociation of molecules, we have never yet found effects of polarisation similar to that when water is being decomposed in gases. Attempts have been made to explain why such phenomena could not happen in gases. We have looked very carefully for that phenomena of polarisation in this secondary conduction. When we got hydrogen in the tube there was no trace of polarisation with aqueous vapour or hydrochloric acid, or with a number of combined gases there was only a trace of polarisation, but as soon as we introduced hydrocarbon or some particular gas in the gas, then you at once got very

* Paper read before the British Association at Edinburgh.

marked phenomena of polarisation. Start first with platinum electrodes, send a current through the secondary electrodes from a battery of 10 or 20 cells, and you get a steady current which can be measured with a galvanometer, as soon as you introduce this gas; then break the current and connect the electrodes with a galvanometer or electrometer; then you get four or five volts back E.M.F. from these cells, and the way in which the effect falls off is exactly that in which it falls off in water—the law of tracing out polarisation effect is exactly the same, of course the resistance in the air is enormous, so that the currents are very small. We found the safest way was working electrometers, with proper precautions. The falling off, so far, seems to point necessarily to some work done by the current of the nature of electrolysis, but when we introduced other electrodes, we found that the effect depended to an enormous degree on the nature of the metal which forms the electrode. With copper or iron we hardly get any effect, and that may be in itself a proof of the reality of the phenomena. In tubes after tubes, with different kinds of hydrocarbons, whatever the platinum was in itself, we got certain E.M.F.'s which we proved to be independent of a number of other circumstances, such as gas. But while with copper or iron we only got very small effects of polarisation, with magnesium the effects of polarisation increased to an enormous extent. I am almost afraid to give the number, but with magnesium electrodes after currents had been passed for a long time, so that the changes appear to take place and become permanent we got a back E.M.F. of 35 volts from a single cell. That shows it is not an ordinary effect of the gas decomposition, but that it is an effect which may be similar to that of the secondary cells, and that is what I call these effects of secondary cells. The magnesium electrodes which were used in these experiments, both a positive and negative, have on them a deposit, which appears to be a finely-divided surface of carbon, which is deposited by the discharge on the magnesium, which probably forms a loose compound with the magnesium. The gas under the influence of primary discharge is able to act as an electrolyte, in so far as the primary cells are concerned. Prof. Arrhenius has been working independently of me in the same line. His experiment was arranged a little different; he introduced plates or wires of zinc or platinum, simply connecing them to the galvanometer. The results obtained from these experiments have been already described by Prof. Arrhenius.

ON CERTAIN VOLUME EFFECTS OF MAGNETISATION.*

BY PROF. CARGILL G. KNOTT, D.SC., F.R.S.E.

The experiments had to do with the changes of the internal capacity of five iron and five steel tubes, each set having been cut from the same bar and bored to various bores. All had the same length, 18in., and the same external diameter, 1½in. The iron tubes were distinguished by the Roman numerals I. to V., and the steel tubes by the corresponding Indian numerals 1 to 5. Tubes of the same number had equal bores. Thus the internal diameter of Nos. I. and 1 were 1¼in., of Nos. II. and 2 1in., and so on to Nos. V. and 5, which had each an internal diameter of ¼in. Each tube was closed below. When set up for experiment it was closed above by a screw nut through which a capillary glass tube passed, and was then placed vertically in the heart of the magnetising coil. The whole of the metal tube and part of the capillary were filled with water, and the changes of internal volume were measured by the motion of the liquid meniscus in the capillary. In strong fields this motion was easily seen by the naked eye. It was shown at the meeting projected by the lantern on the screen. The measurements were made by means of a micrometer microscope.

The observed changes of volume amounted in some cases to nearly 5×10^{-4} cubic centimetres, and in the narrower bored and thicker-walled tubes it was evident that higher fields than those used would have produced still greater volume changes. The highest field that could be safely used was 1,100 C.G.S. units.

* Paper read before the British Association at Edinburgh.

The general characteristics may be briefly described thus: In No. I., 1 and 2, the effects were very similar, differing only in detail. In low fields the capacity was diminished, in high fields increased. In other words, the graph showing the relation between magnetising force and change of volume began by passing under the line of zero change, then crossed it and continued thereafter above it. In Nos. II. and III. a similar form of graph was obtained, only it did not reach the zero line after the maximum decrease was passed. In these cases, as in the case of No. IV., the capacity was always diminished. No. 3 showed increase of capacity in all fields from the lowest to the highest. Nos. 4 and 5 began by showing increase in low fields, but in fields higher than 200 units showed decrease of capacity. A similar but less marked effect was obtained with No V.; in other words, the graphs of Nos. 4, 5, and V. passed first above the zero line, then cut through it, and passed in almost rectilinear course below it, continuing so to the highest fields attained. The following scheme gives the nature of these changes, minus meaning a diminution of bore—i.e., an average contraction of the walls of the tube as a whole—and plus an increase of bore or average expansion. By low fields we mean fields of less than 200 units. The numbers are the greatest measured values of the dilatations, or changes per unit volume, and are maximum or minimum values in all the low fields, except in the case of No. 3 and No. IV.

Increase of Capacity (in 10^{-5} cubic cm.) of Iron and Steel Tubes.

Iron tubes.			Steel tubes.		
Nos.	Low field	High field.	Nos.	Low field.	High field
I.	17	+ 11	1	10	+ 42
II.	− 19	6	2	− 12	+ 15
III.	25	26	3	+ 12	+ 40
IV.	− 14	31	4	+ 2·4	41
V.	+ 0·5	32	5	+ 2·3	13

The greatest change per unit volume was obtained in the case of tube 4. In field 1,000 the dilatation amounted to -4×10^{-6}.

It was necessary to subject the tube to each magnetic field taken first in one direction and then in the other. If this precaution were not taken, the material got into a state of magnetic bias. Very interesting results were obtained when a smaller field was applied after a greater field, the magnetic bias, or "after-effect," due to the larger field having a very pronounced influence. To get rid of this magnetic bias it was sufficient to neutralise the tube by subjecting it to a series of fields of diminishing intensity and alternating direction.

THE ELECTROMAGNETIC STEELYARD.

BY PROF. M. H. JACOBI.

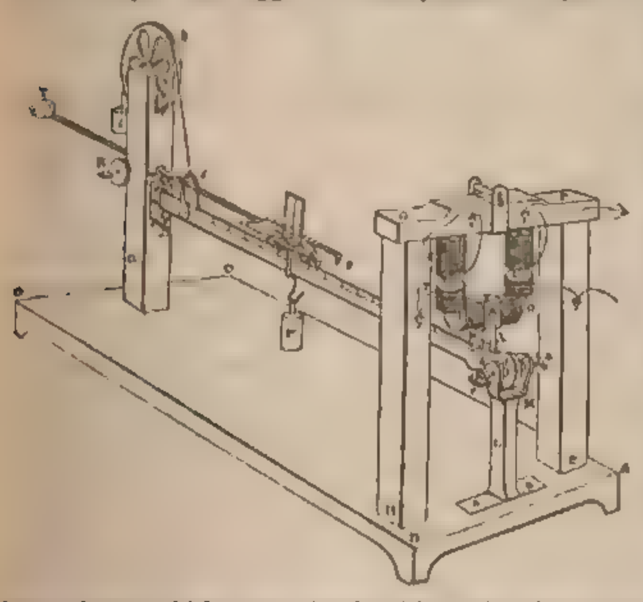
[We think this apparatus should be better known than it is, and have for a long time intended to find room for the description which we now give.—ED. *E. E.*]

A, B, C, D is a strong board resting on four feet, on this is fixed a frame, consisting of two strong posts and a cross beam, E, F, G, H. F, G is designed to support an iron bar, K, bent into the form of a horseshoe, and surrounded with copper wire.

It is of a paramount importance to secure this bar firmly in its position. L is a strong iron stem, divided at the top in order to receive in its two branches the steel screws denoted by *a* and *b*. These screws are pointed, and between them moves, with very little friction, the axis *c*, *d* of the iron lever M, N. This lever is 4½ft. long. Its upper edge is perfectly rectilinear, and fines off on each side like a sloping roof. Exactly 2¾in. from the central point of this lever it is made stronger, and is perforated perpendicularly, to receive a strong pin, which is fitted with tolerable accuracy, and which terminates above in a screw.

Underneath the pin has a nut, *e*, and is fastened below by a joint-piece, but above by a female screw, so that the free revolution round its axis is not prevented. The screw in

which the pin terminates above supports, as regulated by the female screw, a strong piece of brass, *f*, *g*, in which is firmly fixed the anchor, O, P, surrounded by copper wire. This piece of brass has on each side an oblong cleft, into which are introduced two corresponding connecting bars, fastened to the lever, of which one, *h*, is visible. It is evident that when the bolt is turned on it axis, the brass piece, *f*, *g*, together with the anchor, O, P, surrounded by wire, may be raised or lowered perpendicularly, so that the poles of the opposite horseshoe may be brought nearer, or kept further away. The end of the lever supports a gimbal, *i*, to which is fastened a string that passes over the pulley, *k*, and supports the weight, *e*, which counterpoises the lever to the post, O. This last supports the regulating plate. On the shoulder-piece, *m*, *n*, are two adjusting screws, *o*, *p*, employed partly to keep the motion of the lever within due bounds, and partly—so far as the upper screw is concerned—to check the motion of the lever, *i*, when, after the same is counterpoised, the battery circuit is complete, and the magnetic attraction takes place before the measuring begins. P′ is a running weight that hangs on a hook attached to a small waggon furnished with tram wheels, and which may be moved to and fro between the fork-like termination of a toothed rod, S, T, in which the ratched wheel, R, works. By means of a sliding bar (not visible in the sketch), the latter may be used as a catch, so that till then the toothed rod can be moved freely. The waggon carries a plummet suspended



from a frame, which must coincide with a point that is on the waggon in order to secure the horizontal position of the lever. For this purpose I afterwards applied a level. The distance from the fulcrum of the lever to the point whence the weight is suspended is exactly 4ft. 2in., that is 20 times the distance from the fulcrum to the axis of the pin, which distance has been taken at 2½in. The poles of the horseshoe, as well as those of the anchor, are cylinders rounded off, so that their four extremities and the axis of the pin may be situated in a plane at right angles to the surface of the lever. This plane may be regarded as that in which the centre of gravity of magnetic attraction is situated, so that if we designate the distance of this plane and that of the running weight, P′, from the fulcrum, by *a*, and *n*, *a*, the attractive power, $M = n, P'$. The scale on the side of the lever is divided into $\frac{1}{10}$in., so that by means of an index on the waggon of the running weight $\frac{1}{12}$th of the weight may be immediately read off, and $\frac{1}{120}$th estimated. Unfortunately, the apparatus is not strong enough in many parts to measure any very great lifting powers.

In the experiment which my colleague, M. Lanz, and myself made with it, we confined ourselves to from 200lb. to 300lb. I may also mention that there are several circumstances which, notwithstanding the utmost precautions, affect the accuracy of observations. These, experience will point out, and I may add that if anyone would desire to perform exact experiments on the lifting power of the electromagnet, he may advantageously make use of the instrument here described.

BUSINESS NOTES.

Commercial Cable Company.—This Company has declared a quarterly dividend at the rate of 7 per cent. per annum, payable October 1.

Waterford.—The inhabitants are protesting against the decision of their Town Council to abandon the use of the electric light for its streets.

Dundee.—Mr. James Small has been appointed Inspector of the conduits now being laid in different streets for carrying the electric wires.

Burnley.—The town clerk of Burnley has received from the Local Government Board sanction to borrow £23,500 for the electric lighting of the borough.

New Telephone Company.—Share certificates of the New Telephone Company, Limited, may now be received at the offices, 110, Cannon street, E.C., in exchange for bankers' receipts.

Western and Brazilian Telegraph Company.—The receipts of this Company for the past week, after deducting 17 per cent. payable to the London Platino Brazilian Company, were £2,753.

Henley's Telegraph Company.—A dividend at the rate of 7 per cent. per annum on the preference shares of this Company, for the six months ending the 30th June last, will be paid on the 1st Oct. proximo.

Telephony.—The work of laying the telephone between Madrid and Barcelona is well advanced. A telephone line will shortly be installed between Teocuitatlan, Tuxcueca, Tizapan, Pueblo Nuevo, and other villages and haciendas.

Concentric Wiring.—Andrews's concentric wiring is being adopted in five of the beautiful chapels and dining halls of the colleges at Cambridge. This system has been selected to avoid the disfigurement of the interior that would result by wood casing.

City and South London Railway Company.—The receipts for the week ending September 11 were £768, against £665, for the same period last year, or an increase of £103. The total receipts for 1892 show a total increase of £724 over those for the corresponding period of 1891.

New Branch.—A new branch and showroom has been opened in Hull by Messrs. Woodhouse and Rawson United, Limited. It is at 13, Paragon arcade, and is managed by Messrs. Horne and Livingstone, under the superintendence of the Company's branch at 41, Piccadilly, Bradford, Yorkshire.

Ryde.—The traffic upon the electric tramway at Ryde is increasing, which is only natural during the summer months. The charge now is one penny for the journey. The whole installation seems to be in admirable order, and exceedingly well managed under the superintendence of Mr. Roberts.

Whitehaven.—In addition to the tenders which were notified as being accepted in our last issue, viz., those of Messrs. Ramsay Bros., Messrs. Galloway, and the Okonite Company, we understand that the tender of Messrs. Willans and Robinson for four sets of Willans engines and Crompton dynamos has been accepted.

Bradford.—The committee proposed to the Council the acceptance of tenders for the extension of the works in Bolton road, at a cost of £2,745. 9s. 4d., and the purchase of an additional length of main cable from Messrs. Siemens Bros. for the extension of the Kirkgate service. This cable will be 1,075 yards long, and the cost £828.

Bradford.—On Tuesday at the meeting of the Bradford County Council, it was stated that there had been a profit in the electricity department during the past year of £387. 7s. 2d. Since the commencement of the works in 1888 there had been a loss of £799. 10s. 8d., but it was hoped to materially reduce that during the next half year.

Scarborough.—Mr. Bernard Drake has attended a meeting of the Electric Lighting Sub-Committee and fully discussed with them the question of the electric lighting of the borough. He has been instructed to prepare a report as to the terms on which he would advise the Corporation to transfer their powers under the provisional order to a company.

Portsmouth.—The latest time for sending in tenders for the buildings pertaining to the electric light station is 6 o'clock to-day. We have carefully examined the plans of these buildings, and the arrangement seems admirable. The consulting engineer for this scheme is, as is well known, Prof. Garnett, and the engineers Messrs. Waller and Manville.

Wiring and Fitting.—We are informed that the contracts for the supply and fitting with electric light of three of the largest buildings in the City of London, namely, Leadenhall House, New Zealand chambers, and Billiter avenue buildings, comprising over 1,500 16 c.p. lights, have been signed this week by Messrs. H. Binko and Co., of 34, Leadenhall street, E.C.

Aberdeen.—As the result of the decision of the Town Council to introduce the electric light, which was reported in our last issue, in which report reference was made to Prof. Kennedy's estimated expense, he having been consulted on the subject, we understand the Gas Committee are in communication with Prof. Kennedy to ask him to make the plans and specifications for the proposed installation.

Great Western Railway The Directors are inviting tenders for large quantities of stores; among other things, for telegraph apparatus, telegraph ironwork, copper wire, telegraph poles, and, in fact, all the materials pertaining to telegraphic work. Full information can be obtained from the stores superintendent at Swindon or Paddington. Tenders must be received on or before Monday, the 3rd proximo.

Edison Swan Co This Company has just opened offices at 110, Cannon street. A portion of the space has been fitted up with specimens of the Company's manufacture. A great portion of the showroom is fitted with the exhibits which were lately at the Crystal Palace. Besides the showroom, however, storerooms are also being fitted with goods, so that orders may be supplied direct from the Cannon street premises.

Electric Light on Railways The Midland and the other great railway companies with lines running out of London are preparing to follow the example of the Metropolitan Railway and provide electric lamps for the use of their passengers. The experiment on the Underground Railway, which has now been continued for some weeks, has been found so successful that it is said 10,000 lamps have been ordered for the carriages of the Metropolitan and District.

Internal Work Messrs Vaughan and Brown have fitted the whole of the installing of electric light at the new Trafalgar square Theatre, St. Martin's lane, including all fittings and stage lighting; also at the Bedford Head Hotel, Tottenham Court road, for Mr. Woods, with 800 lamps; the Marble Hall, Strand, for Messrs Gatti Bros; also No 75, Strand, with 200 lamps; the Albert Music Hall, Canning Town, with 600 lamps and plant complete; and the Polytechnic Institution, Regent street.

Brush Company The Directors of the Brush Electrical Engineering Company, Limited, have resolved to recommend to the shareholders that, subject to audit, a dividend at the rate of 6 per cent per annum be declared on the preference and ordinary shares of the Company for the six months ended June 30, 1892 making, with the interim dividend paid last February 6 per cent for the year upon both classes of shares. The transfer books of the Company will be closed from September 19 to 28, both inclusive.

Siam Electric Light Company The affairs of the Siam Electric Light Company are at length to be satisfactorily settled: £20,000 has been advanced by the Treasury out of which the creditors are to be paid. The Brush Company, on receipt of the first instalment awarded by the recent court of arbitration, will send out a staff of men to put the machinery in order, after doing which they will receive the balance of the sum due to them. The concern will then either be put up to auction or taken over by the Government by private arrangement with the Company.

Personal Mr W. H Stevenson informs us that he has resigned his position as country traveller to Messrs Woodhouse and Rawson United, Limited, and has accepted a position as town traveller with Messrs Laing, Wharton, and Down, of 82A, New Bond street W. After a connection of 10 years with Messrs Woodhouse and Rawson, Mr Louis Brockman has resigned his position as supply superintendent, and availing himself of an offer from Mr L. Epstein, the managing director of the Epstein Electric Accumulator Company, Limited, has been appointed manager of that Company.

Western Union Telegraph Company This Company announce that a new office has been opened at 40, Mark lane, E.C., for the reception and delivery of messages for and from all parts of North, Central, and South America, Canada, Bermuda, Bahamas, West Indies, etc. This Company owns the largest telegraphic system in existence having two Atlantic cables, both duplexed, running from Penzance, via Canso, into New York City, connecting with its land line system which comprises 725,000 miles of wire and 21,000 telegraph offices. The central cable office in New York has direct wires to Galveston, Texas, connecting at that place with the cables of the Mexican and Central and South American Telegraph Companies; and also direct wires and cables to Havana, Cuba connecting at that place with the Cuba Submarine and West India and Panama Telegraph Companies for all points in the West Indies.

New Catalogue. We have received from Messrs Dorman and Smith, of Ordsall Works, Manchester, a copy of their most recent catalogue, which contains an illustrated price list of their various manufactures, such as their patent porcelain lampholders and switches. We have at various times illustrated these lampholders and switches, and, so far as we are aware, porcelain has shown that it is admirably adapted for use in this direction. The other illustrations and prices are those of a variety of balance suspension pendants of various kinds, and fittings of every type for shipwork and millwork. It is hardly in our province to enter into the question of cost: the customer must compare the prices of one manufacturer with those of another, remembering always that the lowest priced fitting may in the long run be less economical than a higher priced fitting. Much depends upon the material used and the workmanship employed.

Country Houses It is satisfactory to find that Wales is moving with the times in the way of electric lighting. Messrs F. B. Saunders and Co. have just completed an installation at Velindra for Mr Vyvyan Robinson. The house and stables are lighted throughout, the motive power for charging the accumulators being obtained from a Priestman oil engine, this being the second engine of that type which the above named firm have supplied in this district during the past few months. The same firm have just received instructions to proceed with the lighting of Cottrell for the Mackintosh of Mackintosh, and when completed this will be one of the most important installations in the country. Messrs Saunders and Co. have the lighting of Ely Court now in hand for Mr Insole, and are also arranging for several other large installations in the district. This all points to electric lighting becoming almost universal at no very distant date.

Direct Spanish Telegraph Company. The report of the Directors for the half year ended June 30 states that the accounts for the half year show, after providing for debenture interest, a balance to the credit of profit and loss of £6,178. The traffic receipts show a decrease of £45 as compared with those of the corresponding period of 1891. They may, however, be considered satisfactory, as in the half year of 1891 with which they are compared the present reduced tariff had not come into force. The working expenses are £170 in excess of those for the corresponding period of last year. After putting the usual sum of £2,500 to the reserve fund, the balance of profit and loss amounts to £2,938. Out of this amount the Directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares and a dividend at the rate of 4 per cent. per annum, free of income tax, on the ordinary shares. A balance of £441 will be transferred to the reserve fund.

Southampton. The electric light installation at Southampton is progressing slowly. The apparatus installed is sufficient to generate electricity for about 3,000 lamps. It consists of Marshall's boilers, supplying steam to a Robey engine, which drives a Crompton dynamo for the heavy work. For the lighter work a combination of a Willans engine and Crompton dynamo is used, and this also charges, we believe, three sets of batteries installed. The whole installation is under the charge of Mr. Moncrieff. We understand that the channels for the electric mains have been made from the ground clinkers obtained from the Southampton municipal destructors. It ought to be well known to most people that the ground clinkers from a destructor, mixed with cement, makes a far better mortar than the best sand. At an inspection of the new baths and washhouses the other day we noticed that an electrical generator, supplied by Mr F. M. Newton, of Taunton, has just been erected, and in the course of a few days will be at work.

Leeds Tramways. The negotiations for the acquisition of the entire tramway system of the borough, excepting only the Roundhay Park electric cars, is progressing. The Board of Trade have approved the proposal of the Corporation to serve notice upon the tramways company requiring them to sell the local authorities their undertaking, and the Corporation have instructed their town clerk to serve a notice upon the Company. The town clerk was also instructed to apply to the Board of Trade for the appointment of a referee to fix the price at which the Corporation may acquire the tramways. Progress has also been made as to the purchase of the New Wortley and Meanwood road sections, which do not come under the compulsory powers. The proposals of the Company in a draft agreement have been approved, subject to a few alterations. At the meeting of the Tramways Sub Committee the other day, a letter was read from Mr Graff Baker calling attention to the fact that his agreement with the Corporation for the working of the Roundhay road electric cars terminates on the 31st October next. It was decided to recommend that the agreement with Mr Baker should be extended for a period of 12 months from the date mentioned, on the same terms as before.

Essex Shire Hall The County Councillors of Essex had a recommendation from the Shire Hall Sub Committee under their notice at the last meeting, that Mr M. I. M. Williams be required to make a general preliminary inspection and report as to the probable cost and nature of the work of lighting the shire hall by electricity. The chairman of the sub-committee moved the adoption of this report, and a long discussion ensued, when Colonel Howard moved the rejection of the recommendation, and his amendment was finally carried by 15 to three, 15 members voting for the amendment and three against it. The Essex County Council seem to have a very exalted opinion of the powers of its sub-committee, for subsequently to the rejection of the recommendation it was proposed that the sub-committee should report upon the best means of improving the atmosphere of the courts, and this proposal was carried, but a motion which was also made that an expert should be engaged was lost. In other words this sub-committee of the Essex County Council is supposed to have a sufficiently practical knowledge to make a report that will be worth dealing with. It would not be surprising when the committee report to find that, among other things, recommended for improving the atmosphere would be the introduction of the electric light. At any rate, if it is a question between gas and electricity, we are quite sure that electricity will assist somewhat in making the atmosphere less obnoxious.

Electric Pumping Plant A few days ago a supper was given at the Peddlers Arms Hotel, Hirwain, to a number of workmen and officials of the Aberdare-Merthyr Colliery, in celebration of the starting and working successfully of an expensive electric plant for pumping, erected at the above colliery, owned by Messrs. the Aberdare Merthyr Collieries Company, Limited. The plant was supplied by the well known firm of electrical engineers, Messrs. the Crompton Howell Electric Power, Light and Storage Company, Limited, Llanelly, under the management of Mr G. Beith, of Pontypridd and the careful supervision at the colliery of Mr Joseph H. Evans, now of Cross Inn, formerly of Ynysybwl. The electric power is

supplied by one of Crompton's compound dynamos, driven by one of Marshall and Sons's engines, of 150 h.p., having a flywheel of 14ft. diameter, weighing about $7\frac{1}{2}$ tons, and grooved for 16 1in. diameter ropes. The power is conveyed to the pumps, which are about 2,000 yards from the surface, by means of cable supplied by Messrs. Callender and Co. The pumps, three in number, were built by Messrs. Warner and Son, Walton-on-the-Naze; one has three plunges, 10in. by 18in. stroke, the other two have three plunges 6in. by 9in. stroke each. The water is cleared in the course of eight to nine hours daily, thus doing away with night pumping. This step has been a great benefit to the Company and workmen, as the Company suffered a deal of trouble and expense by keeping the water down by means of steam power, and the workmen losing time and having to work in intense heat owing to the steam connection.

City of London Electric Lighting Company, Limited.—The Directors of this Company have issued a full report of the meeting, which, however, is but little more in detail than our report which appeared last week, though the report as issued contains a number of figures which it is always difficult to obtain with accuracy from a speech. From this we may give the following extract: "The contracts with the City for arc lighting in main thoroughfares required the laying of trenches in 47,072 yards of streets. On June 30 43,134 yards were laid, and now 45,410 yards, leaving to complete 1,662, which will be finished during the next two or three weeks. Of the work in the lesser streets, which is not compulsory, on June 30, trenches were laid 46,378 yards in length, or about $26\frac{1}{2}$ miles; now there are completed 49,412 yards. There has been laid to this date 303 miles of ways. The length of cables drawn in to date is $63\frac{1}{4}$ miles of high tension, and 22 miles of low tension. On June 30 there were in the streets 184 arc lamps, now there are 334. By the middle of this month all arc lamps under the City contracts will be running, excepting a few delayed for special reasons, such as building operations, reconstruction of refuges, etc., our last day really being November 5, so that we are unlike most contractors in being ready before our time. On June 30 there were 11,800 8-c.p. glow lamps on 6,735 yards of main, giving a lamp density of two lamps per yard of main. If this density were to hold good throughout the area of the street work now ready to receive mains, this would give 100,000. In Lombard-street the density is six lamps per yard, and in Cornhill it is very nearly the same." With the report there are a series of very interesting curves, and which, if followed by similar curves year after year, will enable everyone at a glance to see and to answer a great many questions as to progress and cost.

Chelsea.—The surveyor to the Vestry thus reports to the Vestry upon the electric lighting of the district: "At the beginning of the year the Vestry had under consideration the St. Luke's, Chelsea, Electric Lighting Order, and decided to offer opposition thereto, although it was drawn up on the lines of the Board of Trade model order. In April I attended with the chairman of the Electric Lighting Committee at the offices of the Board of Trade, and the Vestry's objections were stated to Mr. Courtenay Boyle and subsequently embodied in writing. The Board of Trade, however, in reply stated that the provisions to which the Vestry objected had been inserted in so many provisional orders which had been confirmed by Parliament, that they could not accept the amendments. The Vestry informed the Member for Chelsea of their objections, but did not at first see their way to appealing direct to Parliament. The matter, however, I considered of such importance that I again brought it before the Electric Lighting Committee, who authorised the preparation of a petition to Parliament against the Bill. The Vestry opposed the Bill in the House of Lords, and, in spite of the objections of the County Council, obtained the desired alterations so as to make the Vestry the electrical authority for the parish of Chelsea.

"At the end of July the Vestry appointed me an inspector under the Electric Lighting Acts, so as to empower me to examine the records of pressure, etc., kept by the electric lighting companies. The Cadogan Electric Lighting Company, not yet having complied with that Act as regards a money deposit, the Board of Trade have not served them with the usual regulations as to safety and supply, so that the only company keeping records which the Vestry's inspector can examine is the Chelsea Electricity Supply Company. From time to time I have inspected the records kept by this company, and find that the pressure recorded by their instruments is always above 100 volts, it usually being about an average of 103 volts, except on one or two occasions when alterations were being made to the engines. I consider that their system shows very satisfactory results, and I am of opinion that they keep well within the limits laid down in the Board of Trade regulations.

"The number of houses lighted by electricity in Chelsea was:

	1889-90.	1890-91.	1891-92.
Chelsea Electricity Supply Company	113	215	312
Cadogan Electric Light Company	25	16	18
London Electric Supply Corporation	1	2	2
	139	233	332

It thus appears that about 100 houses have adopted electric lighting during each of the last two years.

"The Overhead Wires Act, which was passed in July, provides that by-laws for the regulation of such wires were to be made by the County Council with the approval of the Board of Trade. In December the Council forwarded a copy of the suggested by-laws to the Vestry, and certain slight alterations I suggested therein were approved by the Vestry and forwarded to the Board of Trade, but at the end of the year no enquiry had been held, nor had any by-laws been approved. On November 3rd I was formally appointed by the Vestry inspector of overhead wires under the London Overhead Wires Act."

Blackpool.—We were able in our last issue to give the definite statement that the troubles relating to the Blackpool tram lines had been sufficiently overcome, and that the Corporation were to purchase for a stated sum. We believe that last Friday a cheque for the sum of £15,750 was paid in to the account of the Blackpool Electric Tramway Company, and that on Saturday the Corporation commenced to run the line, Mr. J. Hesketh, the Corporation's electrical engineer, taking charge in the place of Mr. J. Lancaster, the latter gentleman remaining as outdoor traffic manager. The *Blackpool Gazette* gives the following information upon the whole question: "The Directors of the Company had sent in a claim for over £18,000, as being the amount they required for the transfer of the works in Princess-street, the cars and the electrical installation generally. Auditors on behalf of the Corporation had gone through the accounts and found the sum the Company were really entitled to was £14,840. However, there had to be a give-and-take principle adopted, and as a result of the first part of the conference, the Directors reduced their claim to £16,000, and the Corporation representatives increased their offer by slight advances to £15,500. Neither side, however, were prepared to give in any further, and a deadlock was arrived at. Threats were now used on both sides, the tramway directors intimating that they would refuse to permit the Corporation to work the line after Friday unless their claims were satisfied. The members of the Council, however, responded that they did not fear any action the Directors might take, as they had no doubt a mandamus compelling them to hand over the works could easily be obtained. The negotiations were thus broken off and the parties were separating—in fact, some of the gentlemen had left the room—when, fortunately, wiser counsels prevailed, and the Mayor and Mr. Horsfall, chairman of the directors, had a word or two together. The result was that the Corporation representatives offered to 'split the difference,' to divide the £500 in dispute, and the Directors accepting this decision it was therefore definitely arranged that the price to be paid by the Corporation for the whole of the electrical installation should be £15,750. All things considered, this arrangement may be said to be a very satisfactory one, as it prevents many difficulties and considerable expense in the way of arbitrations, etc., in the future. The next course will be to wind up the affairs of the Blackpool Tramway Company, and after returning the original capital invested by the shareholders, it is expected that they will receive a fairly handsome bonus. The Company have altogether issued 3,000 shares, but upon 2,850 of them only £8 10s. has been called up. One hundred and fifty shares of £10 each have been allotted to Mr. Holroyd Smith under the agreement of seven years ago. The total share capital therefore is £25,725. In the last balance-sheet, the Company showed a sum of £6,069 in hand as a depreciation and reserve fund account, £2,000 of this amount being invested in the Bank of New Zealand, and £1,500 in the Bank of British Columbia. Then, of course, the profits for the present year, which should amount to close upon £3,000, will be available for distribution among the shareholders. Add these approximate amounts to the £15,750 they are receiving from the Corporation, and you have a total not far short of £24,000. All things considered, therefore—though, of course, we do not advance these figures with any definite degree of accuracy—the shareholders should receive a very handsome bonus upon their original investment, in addition to the good dividends—last year's was $7\frac{1}{2}$ per cent.—they have been paid during the last seven years. Mr. Alderman Bickerstaffe, who owns 115 shares, is the largest holder on the Board of Directors; Mr. T. Shaw, M.P., owning 58, Mr. T. Ormerod 30, Mr. T. H. Morris 20, Mr. J. Addie and Mr. J. Broadbent 10 each."

Barnet.—At a special meeting of the Local Board on Thursday in last week, the question of the electric lighting was formally discussed. As we have previously stated, a committee has been obtaining information, which may perhaps assist others if we give the replies obtained from Chelmsford and St. Pancras to the questions which were prepared by the clerk of the Board.

How long has the electric light been in use in the district?—Chelmsford: Since April 14, 1890. St. Pancras: Since last November.

Do you use it for public or private lighting, or for both?—Chelmsford: Both. St. Pancras: Both.

What is the area lighted?—Chelmsford: Thirteen miles of streets. St. Pancras: Five and a half miles public, five and a half miles private.

Is the light supplied by yourselves or by a company?—Chelmsford: Crompton and Co., Chelmsford Electric Lighting Company, Limited. St. Pancras: Ourselves.

Does your system of private lighting pay, and if so, to what extent?—Chelmsford: No answer. St. Pancras: No answer.

Under what authority, special Act, provisional order, license?—Chelmsford: License from Board of Trade; minimum, five years. St. Pancras: Provisional order, confirmed by Act.

Has more than one company been admitted into the district? Has any inconvenience been experienced therefrom?—Chelmsford: No other company. St. Pancras: None.

What system is in use for public lighting?—Chelmsford: incandescents 32 c.p., alternating transformer system, parallel; arcs 1,000 nominal, direct current (series). St. Pancras: Parallel wire, high tension.

What candle-power lamp is found to combine efficiency and economy, (*a*) as to public, (*b*) as to private lighting?—Chelmsford: 32 c.p., 80 c.p. lamps where possible. St. Pancras: Nominal 2,000-c.p. public, 10,000 16-c.p. private.

What is the cost of the light, as compared with gas, having regard to the illuminating power? Chelmsford 32 c.p., £2 6s 10d; arcs, £22 10s., cleaning, etc. St Pancras No answer.

What is the price of gas per 1,000ft., and what do you charge per unit for electricity? Chelmsford: Gas, 4s. 6d *Vide* agreement. St. Pancras. 2s 2d gas per 1,000ft public; 6d. per unit Gas, 2s 9d per 1,000ft. for private consumers.

Is payment made by meter or by periodical sums (*a*) for gas, (*b*) for electric light? Chelmsford. Streets per lamp, private by meter St Pancras By meter.

What method is adopted to provide against failures of the light? Chelmsford All plant is duplicate St. Pancras: Good plant.

How is uniformity and steadiness of light maintained? Chelmsford: No answer. St. Pancras: Seven machines; two spare.

Are the lines carried overhead? Has any accident or inconvenience been experienced therefrom?—Chelmsford: Overhead; no. St Pancras Underground

What control is possessed by the lighting authority over the undertakers *a* as to charge for private lighting, *b* as to public safety or damage to property, (*c*) as to interference with roadways or footways? Chelmsford License St Pancras: Dual control

What was the cost of obtaining your order beyond the £50 deposit to the Board of Trade (*a*) with regard to the printer's charges, (*b*) solicitor's costs, (*c* machinery? If the provisional order is in your own hands, do you practically sublet it to a contractor? If so, at what cost?—Chelmsford About £100. St. Pancras Total £250. No.

Had you any opposition, and was it successful? Have you successfully objected to any application from outside undertakers? Chelmsford No opposition either way St. Pancras Not known. Order obtained 1883 Application 1890 was made by another company. Vestry asked Council to extend order

Other information was received from Maidstone and from Chatham, and the committee recommended "that the Board take the necessary steps to obtain their own provisional order in the ensuing session" After a long discussion, the reports of the committee were adopted, and by another motion the Electric Lighting Committee was reappointed with an additional member

PROVISIONAL PATENTS, 1892.

SEPTEMBER 5.

15876. **Improvements in and relating to telephonic instruments** James Muirhead, 96, Buchanan street, Glasgow.

15887. **Improvements in and apparatus for obtaining metals by electrolysis.** Hans Heinrich Frei, 46, Lincoln's inn fields, London

SEPTEMBER 6.

15958. **Cox's "Multum in Parvo" electric top band for boots** Charles James Joseph Cox, 81, Lavender hill, Clapham, London.

15959. **Improvements in pneumo dynamo meters** Edmond Savary d'Odiardi and Eva Savary d'Odiardi, 55, Cornwall gardens, London

15960. **Improvements in the means of conveying or administering electricity for medical purposes or others** Edmond Savary d'Odiardi and Eva Savary d'Odiardi, 55, Cornwall gardens, London

15961. **Improvements for charging vapours for inhaling purposes or others with electricity** Edmond Savary d'Odiardi and Eva Savary d'Odiardi, 55, Cornwall gardens, London.

15962. **Improved means for administering electricity to animals or human beings** Edmond Savary d'Odiardi and Eva Savary d'Odiardi, 55, Cornwall gardens, London

15963. **Improved means for administering or conveying electricity for medical or other purposes** Edmond Savary d'Odiardi and Eva Savary d'Odiardi, 55, Cornwall gardens, London.

15969. **Improved electric cork ribbed belt** George James Speed, 18, Denman street, Regent street, London

15972. **Improved arrangements of pulleys and bands for driving machines from electromotors** Siemens Bros and Co., Limited, 28, Southampton buildings, Chancery lane, London. (Messrs Siemens and Halske, Germany)

15991. **The manufacture and production of compositions of matter suitable for use for bearings, packings, projectile guides or rings, electrical conductors and analogous articles.** Philip Henry Holmes, 47, Lincoln's inn fields, London. (Complete specification)

15992. **Improvements in the manufacture of composition bearings, packings, projectile guides or rings or analogous articles, applicable also for use as electric conductors** Philip Henry Holmes, 47, Lincoln's inn fields, London (Complete specification.)

15994. **Improvements in electrical conductors** Philip Henry Holmes, 47, Lincoln's inn fields, London (Complete specification)

15998. **Improvements in the manufacture of electric circuits and cables** Alfred Vincent Newton, 6, Bream's buildings, Chancery lane, London. (John Arnold Barrett, United States.) (Complete specification.),

15999. **Improvements in the manufacture of electrical circuits, cables, and other articles alike subject to flexure.** Alfred Vincent Newton, 6, Bream's buildings, Chancery-lane, London (John Arnold Barrett, United States) (Complete specification)

SEPTEMBER 7.

16014. **Improvements in phonographs.** John William Mackintosh, 55, Chancery lane, London (Complete specification)

16046. **An improved process of and apparatus for the electrolytic decomposition of alkaline salts.** Hamilton Young Castner, 55, Chancery lane, London

16055 **Improvements in dynamo-electric machinery** Thomas Richard Freeman and William Waller Pope, 45, Southampton-buildings, Chancery lane, London.

SEPTEMBER 8.

16114 **Improvements in signalling announcing and advertising by electric or other light on the clouds or other vapour, and in apparatus therefor.** Edward Curtice, 77, Chancery lane, London

16124 **Improvements relating to telephonic switching apparatus** Alfred Rosling Bennett, 45, Southampton-buildings, Chancery lane, London.

16128. **Improvements in soldering joints of electric wires** Walker Moseley, 82, Montpelier road, Peckham, London.

SEPTEMBER 9.

16138. **Improved means for transmitting telegraphic signals through submarine and like cables.** Henry Alfred Charles Saunders, 124, Chancery lane, London

16142. **Improvements in telegraphic receiving instruments** Johannes Feydenlahl Hoffgaard, 17, St Ann's square, Manchester (Hans Peter Fryd, Denmark)

16176. **Improvements in the means or apparatus for measuring electricity** Edward Howard Percy Humphreys and William Friese Greene, 35, Chancery lane, London

SEPTEMBER 10.

16201. **Improvements in galvanic batteries.** Jean Baselli Fachris, 151, Strand, London.

16234. **An improvement relating to electrical switches, sockets, cut-outs, and like electrical appliances** Samuel Thomas Wynd and Louis Schraumm, 9, Warwick-court, Gray's inn, London

16262. **Improvements in the electrolytical decomposition of alkaline chlorides for the production of chlorine and alkalies and in apparatus therefor** Camille Alphonse Faure, 46, Lincoln's inn fields, London

SPECIFICATIONS PUBLISHED

1889.

12901. **Electric accumulators.** Crompton. (Second edition)

1890.

13987. **Electricity counter** Richard and others (Amended specification

1891

13714 **Measuring electric currents** Miller

14099 **Electrical measuring apparatus** Reckenzaun

17148 **Electric switches** Sayers

17581 **Electric insulators** Morgan and James

17719. **Electric battery** Byng

17818 **Electric transformers** Pyke and Harris

18285. **Electric switches.** Burton

19014 **Incandescent electric lamps** Lake. (Société dite Electriciteits Maatschappij Systeem de Khotinsky)

1892

1737. **Electric clock mechanism** Boult (Ellis)

3869 **Electrical push button** Elliot

11617 **Dynamo machines** Hall

11849 **Electric circuit boxes** Bergmann

13167 **Electric arc lamp** Irish

13221 **Telephones** Deckert

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	Price Wednesday
Brush Co.	–	[illegible]
— Pref.	–	[illegible]
City of London	–	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
House to House	5	[illegible]
Metropolitan Electric Supply	–	[illegible]
London Electric Supply	5	[illegible]
Swan United	3½	[illegible]
St. James	–	[illegible]
National Telephone	5	[illegible]
Electric Construction	10	[illegible]
Westminster Electric	–	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]

NOTES.

Havre, like Portsmouth, is to have transformers under the public streets.

Platinum, in good quality and of considerable quantity, has been found on the Pacific coast.

Houses of Parliament.—The House of Lords is to be lighted throughout by electric light.

Electric Velocipedes will be made for sale shortly by the Société des Etablessements Decauville at Paris.

Heilbronn, the only town using the multiphase current in a central station, has already a demand equal to 4,200 lamps.

Popp Company.—M. Victor Popp is leaving the post as director of the Popp Company to take the position of consulting engineer to the company.

Specifications.—A work entitled "Electric Lighting Specifications" has been issued by Mr. E. A. Merrill, at the W. J. Johnston Company, of New York.

Ammonite.—The new explosive, ammonite, by the use of electric firing and careful tamping, does away with any flames, and is coming into use for fiery mines.

Crewe.—A definite scheme for the establishment of a technical institute at Crewe is being considered. A special feature will be made of engineering in all its branches.

Coast Communication.—It was stated at the meeting of the Dover Town Council on Wednesday that the East Goodwin lightship is to be telegraphically connected to Dover.

Church Decorations in Paris.—The church of the Sacred Heart, on the heights of Montmartre at Paris, has been lighted up during the celebrations with a large cross of electric lights.

Atlantic Lightships.—The French Transatlantic Company is stated to be considering a proposal that light ships connected by telegraph cables be stationed at intervals of 300 miles across the Atlantic.

Telephone in Austria.—The long distance telephone between Trieste and Vienna has been connected to Prague, a total of 728 miles. From end to end the sounds are perfectly clear, and conversation is carried on with ease.

Electric Fly Trap.—A new fly trap is driven by an electric motor, and kept in shop windows. It drives a broad band smeared with some sweet substance, the flies alight, and are carried along, and then swept off into a wire trap.

Naval Indicator.—The Italian Minister of Marine has definitely adopted an electric indicator invented by an officer of the Italian naval service, and the commandant of the navy has expressed his opinion that it is of incontestible service.

Cyrus Field's Mementos.—Mr. Cyrus Field's collection of curios, medals, and reminiscences of the laying of the Atlantic cable, which, besides his insurance, were all that remained of his once princely fortune, will be exhibited at the Chicago Exhibition.

Barnard Castle.—A correspondent to a Teesdale paper says that in his visit to Ireland he saw both Dublin and Londonderry lighted by electricity, and the lighting was satisfactory. He says the town of Barnard Castle has the advantage of water power and could easily adopt the new illuminant.

Book Received.—We have received from M. Julius Springer, of Berlin, the issue of *Fortschritte der Elektrotechnik* for 1891, being the fifth year of appearance. It contains a large and carefully-arranged mass of information upon electrical subjects, and the advance of electrical industry in Germany generally.

Spain.—The central installations in Spain are extending, much work being done by the firm of Planos, Flaguer, and Co., of Barcelona. The firm have lighted some 20 towns in Spain, and the contract for Tolosa has been awarded to them, in spite of severe competition from foreign firms. It will comprise three turbines of 26 h.p. each, working at a fall of 460ft.

Mount Washington.—The electric search-light on Mount Washington enables a newspaper to be read at Maplewood, 17 miles away. A peculiar appearance is noticed against the white walls of the hotel of dark spots the size of a leaf, floating in the light, which are thought are probably due to the magnified shadow of minute dust specks near the intense arc.

Alhambra.—The Alhambra Music Hall has been beautifully decorated and fitted up with electric light in electroliers of special design round the balcony fronts, and upwards of 120 incandescent lamps have been placed in front of mirrors in the grand circle and stalls. The electroliers are in hammered metal, finished in silver and gold ormolu, and present a most handsome effect.

Car-Motor Regulation.—Herr Kolben having claimed for Sprague the first introduction of combined field-magnet coils instead of resistances for the regulation of electric car motors, M. Reckenzaun writes to the *Electrotechnische Zeitschrift* to say that he patented a similar combination in 1884, and that one of his cars fitted with this regulation was run experimentally in Berlin in that year.

Canal Boats.—The trolley system applied to canal boats is now being once more urged. It would be interesting to know if any experiments or trials whatever have yet been made in this direction. The bargee is proverbially an ignorant and rather degraded specimen of humanity. The smart electrical engineer is replacing the horsey element to some extent, and may invade the domain of the lazy bargee, with profit to his own soul and the purse of his master.

Belfast.—A "Mill Manager" writes to the *Belfast News Letter* to raise the question of introducing electric light into that town. He says he spends over £250 a year for gas, and is told by his friends that they find great benefit from electric light. He thinks that if the Corporation undertook the supply, numbers of mills would take it, and wishes to know the cost. Probably the *News Letter* would insert a contribution from responsible firms giving a few details.

Milan Exhibition.—The proposed electrical exhibition at Milan is to be privately carried out. A charge of 10f. to 20f. per square metre will be made. The programme is extensive, including generators, mains, motors, telegraphy instruments, medical, raw material, engines, teaching historical, literature, and plans for electrical installations. Particulars can be obtained from the Comitato Esposizione di Electrotechnica, Via Amone 9, Milano.

Atlantic Telegraph.—That most interesting and even exciting work, the "History of the Atlantic Telegraph," is about to be issued in a revised form by Mr. Henry M. Field—Mr. Cyrus Field's brother. It was first issued in 1866, and in its revised form should form one of the books necessary to the library of every electrician. It is also one of the best books possible to give to a lad for a Christmas gift—far preferable to fire the enterprise and

inventive imagination than the usual schoolboy adventures, and while being quite as exciting has the inestimable advantage of being true.

Train Lighting.—In the discussion on a paper by Mr. E. C. Riley on "The Development of Gas Lighting in Trains," before the South-West of England District Association of Gas Managers, the author said: "Several railways that have experimented to a considerable extent with the electric light, but have now adopted gas lighting, are in consequence using larger lamps and better burners; the consumption being nearer one cubic foot than the ½ft. previously used." He also remarked that the heavier and darker upholstery in the first-class carriages necessitated the use of two lamps to give as good a light as the lighter and less-upholstered second and third-class carriages.

Electric Lighting of Frankfort-on-the-Maine.—We have received a copy of a printed report prepared by Messrs. W. H. Lindley and Oscar von Miller concerning the proposed central station for Frankfort-on-the-Maine. This report, which is addressed to Mr. Adickes, the mayor of that town, deals generally very fully with remarks made in letters to the mayor in August by the Accumulatorenfabrik Actien-Gesellschaft, of Hagen, and Messrs. Schuckert and Co., of Nürnberg, both of whom had presented schemes for the electric lighting of the town. The reporters do not see their way to any material change being made in the advice given in their previous report made in June last.

City of London College.—The prospectus of the City of London College, or, as it is also termed, the City Polytechnic, contains a very extended list of classes, ranging over 63 different subjects, from agriculture to wood carving, including arts, languages, and sciences, all at the most moderate fees of three to ten shillings per term. Membership at half a guinea entitles to numerous advantages, besides admission to classes at reduced fees. Much attention is given to engineering instruction, and the college in Moorfields evidently gives great opportunity to hard-working students to give themselves higher instruction in special subjects, which they may make good use of for future progress.

New Ventilator for Underground Conduits.—With a view to extract any coal or other explosive gas which may find its way into underground conduits and close to manholes, and so prevent explosions in case of short circuits, the Paris Muncipality has introduced a portable ventilator which can be trundled and worked by one man. It is a centrifugal turbine mounted upon two wheels, and when the hauling handle is lifted up the ventilator is lowered and fits accurately into the top of a manhole, when, of course, the cover is removed. It is possible in the short space of 10 minutes to renew the air in a 600-metre length of conduit, but the Town Council only uses the ventilator for 100 metres at a time. This portable machine has already been successfully applied to the municipal electrical conduits, and one electric light company in Paris is about to adopt it. The idea is worthy of emulation.

Institution Portraits.—Every member and associate of the Institution of Electrical Engineers received, a few months ago, an invitation from Messrs. Barrauds, photographers, of 263, Oxford street, to be photographed for the large picture of the Institution which they proposed to prepare. A free proof of the portrait was sent to each person who accepted the invitation, and now the large photograph is ready. We have received a copy of the photograph, in which the figures of the honourable and ingenious company of electrical engineers are grouped in an imposing hall with side galleries. It is accompanied by a key, 537 being the total number of members present. Those who wish to possess this interesting portrait group can obtain it for two guineas, or framed for a little extra. A key photograph will accompany each picture, which certainly forms an interesting personal reminiscence of the Institution.

Single Arc Lamps.—Arc lamps on a 110-volt circuit are usually run two in series, and if only one lamp is required this means wasting a large amount of voltage in resistance. Why not use incandescent lamps as resistances for the arc lamps, asks Herr C. Heim, and he experiments and reports at length upon his thesis. He used four, six and nine ampere lamps, and concludes that it is perfectly possible to use incandescent lamps thus, and that they may be used for lighting, their fluctuation being not more than 10 per cent., and often not over 6 per cent. He says "With the application of groups of incandescent lamps, an arc lamp burns as quietly as if the excess of voltage were absorbed for wire resistances, and better than if burned in series with a second arc lamp." The protection of the incandescent lamp is secured by a small resistance consuming five volts, which is cut out of circuit after starting. The system has been employed for some time in the Central Hotel of Berlin.

Telegraph Improvement.—The Associated Chambers of Commerce, at their meeting at Newport (Mon.) on Wednesday, passed some recommendations to the Post Office with reference to improved telegraphic communication. In the first place, a resolution was moved that the executive should take steps to obtain telegraphic facilities from all railway stations not closely adjacent to public telegraph offices. This was passed with the addition that telegrams should be retransmitted by telephone where facilities existed. On the motion of the Wakefield Chamber, a resolution was carried that it was unfair to the public to consider the telegraphic department as a separate financial concern as causing unwarrantable delay in much needed reforms, and that the time had now arrived when the address, if not exceeding six words, should be transmitted free. A deputation is to wait on the Postmaster General to urge upon him the adoption of this suggestion.

Exhausting by Mechanical Pumps.—Every improvement in the manufacture of incandescent lamps is being watched with the keenest interest in England at the present moment, when so many manufacturers are holding themselves ready to spring forward upon an open market of the magnitude this has now assumed. A season of cutting prices will set in, and no means to secure economy with efficiency will be left untried. The method recently introduced in America of exhausting the bulbs by mechanical pumps jacketed with a vacuum chamber, seems likely to render considerable service in reducing the cost of this delicate part of the process. A recent test shows the character of the vacuum to be high—higher even than that usually obtained by mercury. A lot of two dozen lamps, after burning 350 hours, only showed a falling off of 1 c.p., with but the slightest trace of blackening. The cost of exhaustion is also very much less on this system than with mercury pumps.

Making it Simple.—Our cousins on the other side have the knack of making people understand, even if they are not scientifically accurate. This is the way voltage has been explained by *Stone* "When a criminal is electrocuted in the State of New York, the newspapers tell how many volts they hit him with, which forthwith sets the reader to wondering what is meant. We might explain this way. Suppose we had a body of water 1ft. deep, to

the bottom of which we attach a hose with three-fourths nozzle, and play the stream on a man at a distance of, say, 4ft. He would, of course, know that he was getting doused with a stream of water, but it would have no other effect. In this case we would be hitting him with what we will call one volt of water, but he would not mind it a bit, as he would scarcely know he was being hit. But suppose we change the hose from the 1ft. head of water to one of 200ft. in height, and let loose on our imaginary criminal. This time we hit him with 200 volts instead of one as before, and if conscious at all, he is conscious that something has hit him, and hit him hard."

First User of the Telephone.—In a recent interview, Prof. Graham Bell says that the first actual telephone line for use was run from Somerville to the office of Stone and Downer, bankers and brokers, 15 years ago. "Mr. R. C. Downer," he says, "now president of the Broadway National Bank, was the first to use it, and when I recall the crude manner in which the line was then constructed, I am surprised that it worked at all." He thinks a great deal of useless talk is indulged in, and advises the tollage system as likely to stop indiscriminate talking, and to conduce to better use for business men. He thinks there is a fortune for the man who will simplify the switchboard service. Mr. Downer, already spoken of, was a young man at the time of the invention of the telephone, and wished to invest, but his father declined, and the chance for future millions thrust upon him were thrown away. The first paid message ever sent over a telephone was sent by Prof. Bell to his *fiancée*, Miss Hubbard, in Cambridge. It was sent from Somerville to Boston (which was the extent of the line at that time) by telephone, and thence by paid messenger to Cambridge.

Foundations.—One of the most important duties of the consulting engineer to a town or public electric company is to be sure that the site is far enough from likely complaints of nuisance, or if in the town that the foundations are of such a nature that no vibration is felt in the houses around. Few electrical engineers except the managers of public supply companies know to what extent complaints are, with reason and without, urged against electric works. The Grosvenor installation was simply bombarded with complaints and injunctions, and the officers' lives were rendered miserable by the constant complaints. They have gone far enough from such a danger now, however. Now there is Morecambe, the Hastings of the North, bearing its tide of complaint on the same score. At the Local Board meeting a deputation of lodging-house keepers attended to protest against the vibration of the machinery of the electric light company's central station in Edward-street, which damaged their business, frightening away intending visitors. The deputation were advised to sue the company for damages, and the chairman said the Board would do what they could to have the nuisance remedied.

Automatic Controller.—In certain cases it is found advisable, on account of simplicity, to charge by the number of lamps lighted, instead of by meter, for energy supplied. The company so supplying must have a check to prevent a larger number of lamps being lighted than is bargained for, and M. Laille has recently perfected for these circumstances an ingenious controlling apparatus, which is described diagrammatically in *L'Electricien*. A swinging armature is pivoted between the poles of an electromagnet which has three windings, one being in the same direction as the main winding, and the other opposed. These are connected in such a manner that which the resistance in the circuit decreased beyond a fixed amount, as when too many lamps are thrown in, the armature swings over and cuts in a large resistance to the lighting circuit, and all the lamps go down to a dull red. This, of course, is sufficient indication to the householder that he is exceeding his agreement, and the armature swings back when a few lamps are turned out. To illustrate the sensibility of the Laille controller, we are told that one of these instruments was set for 60 lamps on a circuit of 110 volts, and it was found impossible to light more than 62 lamps.

Elihu Thomson's Telephones.—Telephony is a peculiar business, inasmuch as the wholesale supply does not become cheaper than a retail or smaller supply, but rather the reverse. Switchboards are more costly, batteries and instruments have to be inspected and tested, and multiplicity of wires adds to the difficulty. New systems to vary or obviate practical disadvantages are brought out from time to time, and Prof. Elihu Thomson is now coming forward with a new telephone system. Instead of a continuous dynamo or battery power an alternating current is used, but a current of such low periods of alternation—32 per second or so—that although the instruments respond the vibrations do not seriously interfere with speech, as the low hum they produce is almost inaudible in the instruments, and indeed can only be heard by specially listening to it, and then affords a test as to whether the lines are in order. All local batteries are dispensed with, the system having a closed circuit of great flexibility, and may be not grounded at all if desired. The annunciators at the exchange are worked by the simple act of lifting off the telephone, which momentarily opens the circuit. The system is described with diagrams in the *Western Electrician* for September 10, but it does not appear whether any application to an exchange has yet been made in practice.

High-Voltage Lamps.—The attention of incandescent lamp makers has lately been attracted to the production of high voltage incandescent lamps—that is, lamps of from 150 to 300 volts—and a short but interesting article on the subject is given by Mr. Henry E. Vineing in the New York *Electrical Engineer* for the 14th inst. He points out that by the use of such lamps the capacity of the lamps would be doubled. The quality of the glass is an all-important factor in the manufacture of incandescent lamps, and fully 90 per cent. of the maker's troubles are due to this cause, and the quality, he says, should be different for different voltages. Instead of lengthening the filament—the only fibrous material available for such lamps being bamboo—he advises a chemical treatment. He has succeeded in making lamps of a voltage ranging from 200 to 280, with a life of over 500 hours at 3·6 watts per candle by chemical treatment previous to carbonisation at 4s. per 1,000 filaments. High-voltage lamps do not blacken. There is a greater percentage of uniformity in candle-power. During exhaustion the fall of resistance is less in proportion than lamps of lower voltage. His conclusion is that makers of high-voltage lamps will find the solution of the problem in chemical treatment rather than in the use of mechanical devices.

Jerusalem.—The progress of modern civilisation leaves no corner of the earth revolutionised. With the first railway train entering into Jerusalem, bringing at last the steam engine within the sacred walls—a fact which was accomplished for the first time last week—we feel that civilisation, as we understand it, is advancing quickly. Cook's have already set up their tent in the Holy City. We suppose, now that Rome is lighted, Jerusalem can hardly tarry long before introducing the electric light, or even electric tramcars, and we shall hear of "transmission of power from the Brook Cedron," or other source of water power. It is perfectly true, however, that a steady migration of the Jews has been going on for some time

past into Palestine, and the renovation of the old cities under their business instincts is astonishing. The importance of Palestine as a centre between East and West is not less nowadays than it used to be, and with the introduction of railway trains, telegraphs, cars, and lighting along with the Jews, Palestine may regain its prestige, and perhaps not lose its associations any more than other countries have done. The modern colony may prove an important customer in the market, and the interest of the place for travellers of all countries should not make it less prosperous in the future than the Rhine or Switzerland.

Telephone Companies.—In all probability, the secret history of the fine splash made by the New Telephone Company and the neat collapse at the psychological moment of the promised competition will never be fully written. The combination is pretty complete, apparently. The offices of the "New" have passed over into the ancient enemy's camp, and the officers are working in the once hated corner of Oxford court, whence the National spreads its network of wires. The combination was effected, we believe, by a gentleman entirely unknown to electrical fame, stung by the apparent waste of energy (and money) likely to accrue—a mutual friend of both—and once a path was found the two opposites met as quickly as positive and negative. The final result, we may venture to predict, will be that the National part of this electrical centaur will keep and work their provincial business, which is already well organised, well erected, and well maintained in most parts of the country; but that the "New" part of the combination will take the large towns, reorganise as soon as possible the wiring on the twin-wire system in London as in Manchester, and at last, let us hope, we shall have a decent and not too dear service. The question of active competition will be settled, though the true solution in the Government acquisition of the monopoly is yet as far off as ever.

Electric Power on a Holiday.—One of the most charming days this summer has seen was vouchsafed by the clerk of the weather last Saturday for the annual outing of the employés of the General Electric Traction and Power Company. A party of 40 or 50 met at Waterloo and steamed to Hampton Court, where the "largest electric boat in the world"—the "Viscountess Bury," well known to visitors to the Thames—was waiting to take them up the river. The men swarmed in happy groups on the roof of this palatial vessel, which has carried dukes, millionaires, editors, and celebrities galore, and the run was begun with easy motion in the lovely warm air of the brilliant September morning, showing up in a set of glorious pictures the changing views of the banks of the upper Thames. A short stop was made at the Immisch electric charging station at Tagg's Island, where a photograph of the group was taken by one of the party present, and then a clean run was made past a most interesting panorama, by quaint Chertsey, picturesque Shepperton, up to the Pack-house at Staines, where, after light refreshment and more photography, the party returned on boat for the run back. A thoroughly enjoyable outing, due to the initiative of Mr. Immisch, and well carried out by the secretary, Mr Smith, aided by Mr Coppin, was brought to a close by dinner and toasts at The Greyhound, Hampton Court.

Aluminium Boats.—Aluminium seems growing in favour as a matter for launches on account of its light weight, great strength, and silvery appearance. A yacht of aluminium was lately launched on Lake Zurich's "fair waters" by Messrs. Escher, Wyss, and Co. This yacht was built to the order of Mr. Nobel, a Swedish gentleman, for cruising in the Mediterranean. The aluminium was produced by the Aluminium Works of Schaffhausen, and it really seems that the material has a useful future in this direction. The boat is 40ft. long with 6ft. beam, carries 20 passengers, though weighing only 1.6 tons as against three tons for an ordinary yacht of this size. It is fitted with a 6-h.p. naphtha engine, and made easily 10 miles an hour. While electric launches are so popular on the Thames, the originality of an aluminium launch of this description would, we should think, prove a great attraction, and it might be worth while for one of the firms interested in this class of boat to build on commission an aluminium boat for "up the river" trips. We learn that Messrs. Escher, Wyss, and Co. are building another boat of this description specially constructed for overland transportation, for use on the African lakes, a purpose for which the aluminium boat is peculiarly fitted on account of its lightness. The bright appearance of these boats was much admired at Frankfort last year, and their wide extension is evidently only a matter of time.

The Electro-Harmonic Society.—The meeting of friends, conjoined with sweet harmony, is once more promised to the members of the Electro-Harmonic Society in the first smoking concert of the season, which takes place on Friday, September 30, at the St. James's Hall Restaurant (Banquet-room), at 8 o'clock. Artistes: Mr James Brown, Mr. Albert James, Mr. Arthur Thompson, Mr. R. Hilton; violoncello, Mr. W. C. Hann; pianoforte, Mr. Alfred E. Izard; humorous selections, Mr James Kift; musical directors, Mr. T. E. Gatehouse and Mr. Alfred Izard. Programme, Part I: Part song, "The Young Musician" (F Kucken), song, "The Message" (Blumenthal), Mr. Albert James; song, "Quaff with Me the Purple Wine" (Shield, 1784-1829), Mr. Robert Hilton; pianoforte solo, "Prelude and Fugue in E minor" (Mendelssohn), Mr. Alfred Izard; glee, "Songs should breathe" (W. H. Cummings); violoncello solos, (a) "Feuillet d'Album," (b) "Elfentanz" (Popper), Mr W. C. Hann; air (semele), "Where 'ere You Walk" (Handel), Mr Arthur Thompson; humorous song, "Wait till the Luck comes round" (Beney), Mr. James Kift. Part II: Glee, "The Countryman's Song" (W. Horsley); violoncello solo, "Caprice Hongroise" (Dunkler), Mr. W. C. Hann; song, "Maid of Athens" (H. R. Allen), Mr Albert James; song, "The Friar's Song" ("Ivanhoe," Sullivan), Mr. Robert Hilton; pianoforte solo, "Mazurk" (Op. 103), (B. Godard), Mr. Alfred Izard; song, "Mefisto" (Gounod), Mr. Arthur Thompson; humorous song, "The Johnnie's Serenade" (Chevalier), Mr James Kift.

Gas v. Electricity.—Ever since the introduction of electric light, gas companies have looked on the new industry with a certain measure of good-humoured contempt, having considered that it was a toy and would always have to be supplemented by gas. One of the first gas companies to seriously feel the competition of electricity has been the gas company of Carlow, in Ireland, which town Messrs. J. E. H. Gordon and Co., Limited, of 11, Pall mall, have been lighting for the last 14 months. Week by week more lights have been taken on, and at the present moment nearly one quarter of the total revenue of the gas company has been transferred to Messrs. Gordon for payment of electricity. Last night the gas company issued a circular to the inhabitants of Carlow, informing them that any persons using electricity would be at once cut off from the gas mains. Immediately on receipt of a copy of this circular, Messrs. Gordon telegraphed to the town clerk of Carlow, and to their office in Carlow, as follows: "Town Clerk, Carlow,—Please inform inhabitants, whom we hear the gas company are endeavouring to deprive of light, that we are prepared to supply the whole town, and will immediately send over all necessary materials and men to save the town from incon-

venience.—(Signed) Gordon, London." "To Gordon and Co., Carlow,—Use every effort to supply all inhabitants coerced by gas company, and requisition at once for all men and materials required.—(Signed) Gordon, London." A large staff of extra men and all the necessary materials for wiring the rest of the town and for enlarging the plant are being sent over as rapidly as possible. It is to be hoped that the action of the Carlow Gas Company will be followed by other gas companies, and thus will hasten the final displacement of gas by electricity for the illumination of shops and private houses.

Sheffield.—The *Sheffield Independent*, the Liberal newspaper of the cutlery town, has just taken unto itself new and palatial offices in Fargate, and issues a special descriptive number, in which the manifold departments of a large and flourishing provincial daily paper are interestingly shown. The machine-room is 100ft. by 53ft., and contains two Victory machines capable of printing 16,000 copies an hour, and one of the newest forms of the Hoe machine, which will print, fold, and deliver at 24,000 an hour. Two engines, of 145 h.p., built by Shardlow, of Sheffield, stand at one end. They are connected by friction clutches, so that either engine can be started or stopped without affecting the speed of the main shaft. This is of importance as regards the electric light, with which the entire premises are fitted. The installation is as efficient and complete as money and care could make it, and is the work of the Manchester Edison-Swan Company. The dynamo is of the Edison-Hopkinson type, of a capacity equal to 400 16-c.p. lamps, a capacity somewhat above that at present required. The installation now consists of about 350 16-c.p. lamps, and three arc lamps for illumination of the entrance and roadway. Every room in the building is lighted by electricity, and gas is only to be resorted to in case of stoppage. The use of the telephone in the new office is considerable. The *Independent* was the first subscriber to Messrs. Tasker's exchange, and later joined the National system, which they have often found very useful in communicating to different towns. They have besides their own system of telephones throughout the offices, supplied by Messrs. Tasker, each instrument being fitted with its own switchboard for simple and easy intercommunication. Altogether the new offices are exceedingly well fitted up, replete with all the newest improvements, and are a credit to the enterprising proprietors, Messrs. Leader and Son.

Dundee.—The question of the cost of the lighting in Dundee is now exercising the minds of the inhabitants. Messrs. J. P. Smith and Sons, who have had a private installation of their own running for several years, consider from their experience it will cost nearly double the price of gas. The firm have 226 lamps of 16 c.p., and measuring the current taken they find at 5d. a unit their lighting would come to 5s. an hour. But supplying their own motive power they are able to produce the light at 3¼d. a unit, including gas and oil for engine as well as interest on plant and fittings. The work of laying the cast-iron pipes in the streets of the city is proceeding apace, and it is expected that everthing will be in readiness for supplying the light to all within the prescribed area about the end of November. The mains, composed of copper cables of different sectional areas, insulated by vulcanised rubber, will be laid in the pipes and culverts along the route mapped out by the Commissioners. The culverts, which are 4in. deep at the bottom and 6in. wide at the side, are being built of concrete. There are altogether nearly 3,150ft. of culvert. Some of these will contain three copper strips each, and others seven copper strips. The insulators in the culverts will be 6ft. apart. Arrangements are to be made to carry off all water that may gather in the culverts by giving therein a fall of ½in. per yard; in the event of a water-pipe bursting above them damage will be prevented by placing at each box a Buchan trap connected with the sewer, while an escape of gas into the culvert is to be provided against by ventilators placed at a higher level. Those parts of the route not supplied with culverts—which are only necessary in connection with the "feeders"—have cast-iron pipes with mains laid in trenches. As the installation is to be on the three-wire system, three cables of varying diameters and lengths are placed in each pipe. At the corners of streets junction-boxes will be provided for the purpose of drawing in the cables. The distributing mains are being laid down by the India Rubber Company, and the feeders by the Callender Company, the former consisting of insulated cables drawn into cast-iron pipes, the latter of copper strips laid on porcelain insulators in a concrete culvert.

Electric Cooking. — Messrs. Crompton and Co., Limited, are giving close attention to the development of the use of electricity for domestic purposes, including cooking, and in order to bring the advantages of their apparatus before the public, they are showing it at various exhibitions at the present time. The latest exhibit is at the Health Exhibition, Portsmouth, in connection with the Sanitary Congress, where the use of electricity for any purpose other than lighting is a novelty. The large range makers and gas-stove people competed very closely for the medals awarded by those interested. Messrs. Crompton have been more successful than the majority by carrying off two prize medals and highest awards. One was given for the improved electrical cooking apparatus, and the other for improvements in domestic motors, with a new reducing gear applied direct to the motor, thus saving the necessity of bands and pulleys. Messrs. Crompton show a dynamo which drives arc and incandescent lamps for lighting the building, and supplies the current for the cooking apparatus, ventilating fans, etc. The working of the electric kettles, cookers, and hot-plates was watched with great interest by all attending the congress, and it was acknowledged to be a move in the right direction. Mrs. Knight, the cook employed by the institute to demonstrate the use of the gas and other stoves on trial, prepared food by the electric cookers every day, and proved that the electrical apparatus was not only equal, but superior in many respects to the gas cooking appliances formerly employed. Mr. H. J. Dowsing has been down on several occasions and given short lectures explaining the uses of the various apparatus, and altogether the innovation of competing with the makers of coal ranges and gas stoves has created great interest. We understand that it is the intention to introduce electricity as a sole cooking power in several large flats in the West end of London nearing completion, where it was formerly intended to instal gas stoves. The supply companies will make a special reduction for current used for driving domestic machinery and cooking apparatus, and this will encourage its use, and increase the day demand for electricity. Messrs. Crompton are introducing a number of new applications in the way of electric heating, and their showrooms as 148, Brompton-road will shortly be completed. In the window may now be seen kettles boiling by electricity and warming apparatus at work, and the large numbers of passers-by that stop to look in prove the interest evinced in the matter. The Health Exhibition at Portsmouth will remain open for a further three weeks, and during the first week it has been well attended. If visitors are not interested in electric cooking, they will find æsthetic culture in listening to the strains of the band—a band of ladies.

THE EFFICIENCY OF TRANSFORMERS AT DIFFERENT FREQUENCIES.*

BY W. E. AYRTON AND W. E. SUMPNER.

Some years ago Mr. Mordey published in the *Journal* of the Institution of Electrical Engineers the results of some experiments, which appeared to show that when a transformer of the Mordey type of construction was working at a given load, the waste of power was less at a frequency of 100 than at a higher or lower frequency. In 1888, to test this point, experiments were carried out at the Central Institution by Messrs. Lamb, Smith, and Woods, the power put into and taken out of a Mordey type of transformer being measured by the electrometer method, and it was for the purpose of these tests that there was constructed the large non-inductive resistance that was described by Mr. Mather and one of us before the Physical Society last year. But although this method is theoretically one of the best for ascertaining the power given by any current to any circuit, the percentage error in measuring the efficiency is, of course, the percentage error in measuring the power put into or taken out of the transformer. And, as it is very difficult to avoid making errors of 1 or 2 per cent. with the electrometer method, it is almost impossible to be sure of changes of this magnitude in the efficiency produced by a variation in the frequency. Subsequently, tests were made by others of the students, employing other methods for measuring the power, but it was not until one

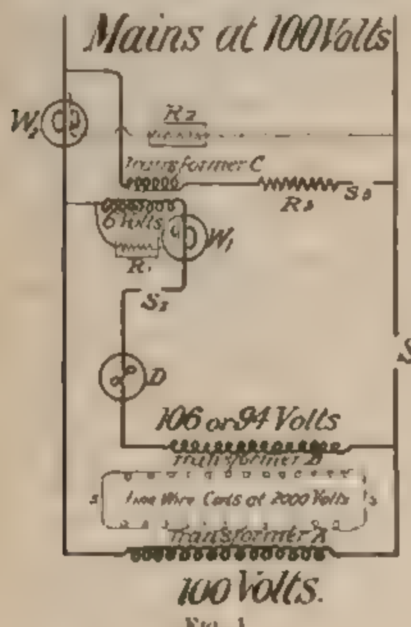


FIG. 1.

of us had devised the method that appeared this year in the technical press for measuring the losses in a transformer *directly* that we felt in a position to express an opinion regarding the actual effect produced by variation of frequency on the efficiency of a transformer. Except under special circumstances, to be subsequently referred to, this method requires for its employment two transformers similar in type and output, and a third transformer, which may be of much smaller output, for supplying the energy lost in the coils of the two large transformers.

The detailed working of the method will be understood on reference to Fig. 1. The fine wire coils of the two transformers, A B, are connected in parallel through the high pressure switches, *s s*. The thick coil of A is connected directly with the mains, while the thick coil of B has one of its ends joined with one of the mains, and the other in series with a dynamometer, D, a switch, S_2, the current coil of the wattmeter, W_1, the secondary of the subsidiary transformer, C, and finally with the other main lead. A switch, S_1, is placed in one of the mains, as indicated in the figure, so that the current supplied directly from the mains can be switched off when desired. The primary of transformer C is connected with the mains through an adjustable resistance, R_3, and a switch, S_3. A wattmeter, W_2, has its current coil joined up so as to be traversed by the current entering the parallel circuit formed by the primaries of A and B, and its pressure coil placed in series with the non-inductive resistance, R_2, across the mains. The pressure coil of the other wattmeter, W_1, is connected in series with the non-inductive resistance, R_1, across the secondary of the auxiliary transformer, C.

If the switches S_1, S_2 be closed, the currents flowing are merely the magnetising currents required for the transformers A and B, and W_2 merely measures the open-circuit losses. Unless the secondary of C be short-circuited no current will flow through the thick coil of B, for the magnetising current is then supplied by the thin coil after transformation by A. If now switch S_3 be closed, so that the secondary of C supplies a P.D of, say, six volts to the circuit formed by the thick coils of A and B, large currents will flow through the transformers. The P.D. between the terminals of A will be of course the voltage of the mains (for example 100), but the P.D at the terminals of B will be either 106 volts or 94 volts, according as the six volts supplied by the secondary of C are in opposite phase, or in the same phase, as the 100 volts between the mains. Indeed, if there were considerable magnetic leakage in the transformer C, or if R_3 were a highly inductive resistance, the P.D. of six volts supplied by C would be out of phase with the voltage on the mains, and the P.D. at the terminals of B might be anything between 106 and 94 volts. If there be a P D. of 106 volts between the terminals of B, this transformer is being used as a step-up transformer, and A is converting downwards. If, however, there be only 96 volts between the terminals of B, it is A which is working as the step-up transformer, and B which is converting downwards. In the majority of the cases to be subsequently described the six volts supplied by C were sufficient to drive the full load currents through the transformers.

The load, W, we take as being measured by the product of the current indicated by D and the P.D. supplied to the primary of the step-up transformer. If A is used for converting upwards, this load is simply 100 times the current in amperes, whereas if B is used as the step-up transformer the power returned to the mains by A is 100 times the current in amperes, and if to this we add the two power losses measured by W_1 and W_2 we obtain the power taken from the mains and supplied to the primary of B. If w be the load in watts supplied to the step-up transformer, if w_1 and w_2 be the watts at this load measured by W_1 and W_2 respectively, and if λ be at the same time the loss of power in the leads used in joining up transformers, in the coils of the dynamometer, D, and in the current coil of W_1, the total loss in the two transformers is $w = w_1 + w_2 - \lambda$, and the efficiency of the double conversion is $\eta = 1 - \frac{w}{W}$.

The advantage of this method of determining efficiency, as pointed out some years ago by Dr. Hopkinson in connection with a similar method of measuring the efficiency of dynamos and motors, is that a small error in determining either w or W will make practically no difference in the calculated value of η. For instance, as the value of η for two transformers is about 90 per cent., w is about one-tenth part of W, and it follows that an error of 10 per cent. in estimating the ratio of w/W only affects η to 1 per cent., and only affects the calculated efficiency of each transformer to one half per cent. It would have been more accurate had we placed the dynamometer, D, in circuit with the thick coil of A rather than with the thick coil of B, but the currents in the coils of A and B for closed magnetic circuit transformers differ to such a slight extent that either current may be approximately taken to represent the load without introducing any appreciable error in the determination of the efficiency.

The instruments used were of a rough character, and no special care was taken with them, for our object was rather to see how far measurements made by this method with common instruments could be relied upon, than to obtain the most accurate results possible. D (see Fig. 1) is an ordinary Siemens dynamometer measuring up to 55 amperes for one revolution of the pointer when the thick coil is in circuit. W_2 is a Ganz wattmeter, supplied, as usual, with two non inductive resistances. In the following

* Paper read before the meeting of the British Association at Edinburgh.

experiments its sensibility was such that one revolution of the pointer corresponded with about 1,200 watts. W_1 is a Siemens dynamometer as made commercially, but modified so as to form a wattmeter by connecting the mercury-cups forming the ends of the movable coil with two separate terminals. This swinging coil was used in series with a suitable non inductive resistance, R_1, as the pressure coil of the wattmeter, one of the fixed coils being traversed by the main current. When large currents were flowing through the thick coils of A and B, a current of eight or ten amperes often passed through the volt coil of this wattmeter and its attached resistance, R_1, but although the power so wasted was quite appreciable, consideration of Fig. 1 will show that the reading of the wattmeter W_1 is not affected by it in the least, and that it thus does not enter into the calculation of the efficiency. An ordinary Cardew voltmeter was used for the adjustment of the potential on the mains.

The transformers tested were M_1, M_2, two transformers of the Mordey type, each of output 4·5 kilowatts, converting from 2,000 volts to 100 volts (or 50 volts). They are numbered 1,871 and 1,872. We shall for brevity allude to them respectively as M_1 and M_2. M_3, one transformer of the Mordey type, of output three kilowatts, converting from 2,000 volts to 100 volts (or 50 volts) Its number is 1,832, and in what follows it is alluded to as M_3. M_4, one transformer of the Mordey type, of output 1·5 kilowatts, converting from 100 volts to 100 volts. It has three coils, each of the same number of turns, and occupying spaces proportional to the numbers 1, 1, and 2 respectively. The transformer was wound in this way for experimental purposes, but in other respects it does not differ in construction from the ordinary type made by the Brush Company in 1887. It is alluded to in the following experiments as M_4. H, one Hedgehog transformer, made by Messrs. Swinburne and Co., of output four kilowatts, converting from 2,000 volts to 100 volts. It is referred to by the letter H. A small transformer of change ratio 6 to 1 was occasionally used as the subsidiary transformer, C. It was not, however, of any recognised commercial type, and the magnitude of its efficiency does not enter into the tests.

The losses in the leads were carefully determined, and confirmed by measurement made with different methods. The same leads and instruments were used in all the experiments. The first method of testing was to measure the resistances of the different coils and leads and calculate the losses at the currents used. These measurements were confirmed by passing steady currrents of 30 and 40 amperes (measured by a standard d'Arsonval galvanometer used as an ammeter in shunt to a platinoid strip) through the leads, and measuring with the aid of a standard voltmeter (a second d'Arsonval galvanometer used in series with known resistances) the power lost in the leads for these currents. The same experiment served to calibrate the dynamometer, D. The wattmeters W_1 and W_2 had been previously calibrated by means of the same two standard instruments. The measurements were made when both the thin and the thick coils of the dynamometer, D, and the wattmeter W_1 were in circuit, since in the actual transformer tests it was occasionally found necessary to change these coils The measurements of the losses in the instruments and leads were further confirmed by tests with alternate currents of the same frequencies as those used in the measurements; and it will be apparent that one of the advantages of the method of testing the efficiency of transformers which we have employed arises from the fact that the apparatus required for the efficiency measurements can be used for determining the losses in the leads, etc., without any alteration of the connections. For if the switch S_1 be open, and switches S_2 and S_3 be closed, and the primaries of the transformers A and B are short-circuited, the reading of the wattmeter W_1 will at once measure the losses occurring in the testing apparatus itself when any special current, measured by D, is passing through it. The measurements made by these different methods were in quite satisfactory accordance with each other. With a current of 40 amperes the loss in the leads, when the thick coils of D and W_1 were used, was 55 watts. When the thin coil of D was substituted for the thick coil, the extra loss at 40 amperes was 70 watts, and an equal increase in the loss was caused by using the thin coil of W_1 instead of the thick coil.

The losses occurring in the coils of the transformers can be measured independently of the other losses by simply leaving the switch S_1 open and taking the reading of W_1 for different alternating currents flowing through D. The two transformers A and B are so connected that a P.D. of a few volts will cause large currents to flow through the thick coils when the switches, *s s*, in the secondary circuit are closed. Of course the iron cores are magnetised slightly, and a certain amount of energy is absorbed by hysteresis, but this is quite negligible compared with that lost in the copper. For at most the voltage corresponding with the induction of the core is only that needed for driving the currents through the resistance of the transformer coils. This is only about 1 per cent. of the ordinary voltage of the transformers, and as the losses in the iron vary as the square of the induction density (more accurately as $B^{1·6}$) the core losses are only $0·01 \times 0·01$—*i.e.*, 0·0001 of the normal losses occurring in the use of the transformer. It thus becomes possible to investigate the very important matter of the variation of the core losses under different conditions of load. All that need be done is to determine: (1) The total losses occurring in core, coils, and testing apparatus for different currents when S_1 is closed; and (2) the total losses in the coils and testing apparatus for the same currents when S_1 is open. The difference between the losses found for any particular current is the loss in the core for that particular load.

It was pointed out in the article in the technical press already referred to that the reading of W_2 practically gave the iron losses in the two transformers, and that W_1 gave the losses caused by the heating effect of the currents in the coils, etc. The measurements made with closed-circuit transformers have entirely confirmed this view. Thus for the two 4½-kilowatt transformers of the Mordey type (M_1 and M_2) tested at 100 volts and a frequency of 160, the reading of W_2 gradually changed from 220 watts on open circuit to 230 watts at a load of 2,500 watts, and to 235 watts at a load of 5,000 watts. Whereas the core losses as determined by the subtraction method were 220 watts on open circuit, 220 watts at a load of 2,500 watts, and 227 watts at a load of 5,000 watts, or practically the same as the watts as measured by W_2. In another test, at a frequency of 150, the reading of W_2 changed from 210 watts on open circuit to 222 watts at a load of 4,000 watts, the iron losses as calculated by the difference method diminishing gradually from 210 watts on open circuit to 200 watts at a load of 4,000 watts. In another test at the same frequency, the reading of W_2 altered from 215 watts on open circuit to 210 watts at full load, while the iron losses were found exactly the same as the corresponding readings of W_2 up to a load of 3,000 watts; afterwards, however, the iron losses were slightly greater. In a test at a frequency of about 100 the reading of W_2 decreased from 260 watts to 250 watts as the load increased up to 4,000 watts, the iron losses being the same up to a load of 2,500 watts, and being slightly less afterwards and equal to 230 watts at a load of 4,000 watts. In a later test at a frequency of 100 the reading of W_2 only changed from 285 watts to 290 watts from open circuit to a full load of 5,000 watts, while the iron losses diminished under the same circumstances from 285 watts to 275 watts.

In all these experiments numerous tests at intermediate loads were taken, and the general smoothness of the curves obtained by plotting the observations is such as to justify considerable confidence in the character of the results, the slight differences between the curves denoting the readings of W_2 and those representing the iron losses are sometimes in one direction and sometimes in the other, and are to be regarded as an indication of the extent of the experimental error to which the measurements are subject rather than as any certain evidence of alteration of the core losses with the load. In fact, the experiments seem to show that with closed-circuit transformers at any rate the core losses are practically constant at all loads. This conclusion is only what theory indicates, but it has frequently been doubted, as many published efficiency tests of transformers have indicated that the core losses diminish as

the load increases. This constancy of the iron losses is further evidenced by tests made with the other two Mordey transformers. Thus, in testing the combination of the 4,000-watt Mordey, M_1, with the 3,000-watt Mordey, M_3, the iron loss at a frequency of 160 only altered from 185 watts at no load to 175 watts at a 4,200-watt load. In another test, at a frequency of 200 the core losses changed from 170 watts at no load to 155 watts at a load of 4,200 watts. In a test of the 1,500-watt Mordey, M_4, the iron losses at a frequency of 160 were found constant within 1 per cent., while the load changed from 0 to 3,000 watts, or double full load.

When the open magnetic circuit transformer was used, the measurements were not so satisfactory. Two or three reasons may be assigned for this. Owing to the large mag-

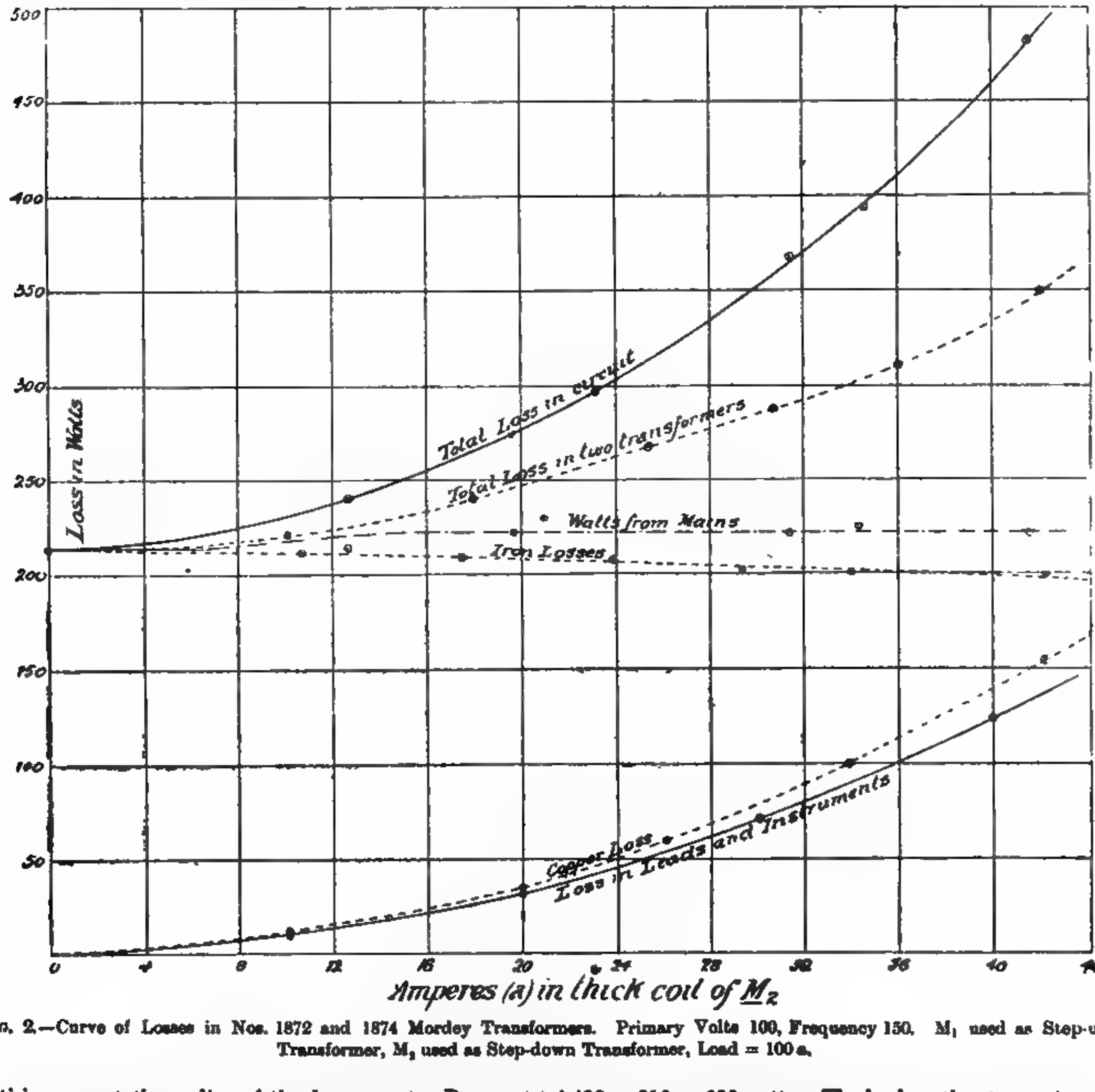


FIG. 2.—Curve of Losses in Nos. 1872 and 1874 Mordey Transformers. Primary Volts 100, Frequency 150. M_1 used as Step-up Transformer, M_2 used as Step-down Transformer, Load = 100 a.

netising current, the reading of the dynamometer, D, cannot be taken to indicate the current in the thick coil of A as well as that in the thick coil of B. Also, owing to the great difference in the regulation of the Hedgehog transformer when converting up or down, the voltage on the transformer C had to be considerably greater than in the previous tests when the full-load currents were flowing; and, consequently, while one of the transformers A, B is worked at the proper voltage, the other is worked at a voltage considerably different from 100. The curves obtained are sometimes of a curious character, and we have not yet had time to fully explain them. As we hope to repeat these tests, we prefer to postpone the publication of the results referring to the core losses of open-circuit transformers. Our experiments, however, indicate that the iron losses do not alter by as much as 10 per cent. when the load is increased from 0 to full load.

Before summarising the results obtained it will be well to explain in detail the arithmetical working by means of which the efficiency is obtained from a single set of measurements with the three instruments W_1, W_2, and D. When the two large Mordey transformers, M_1 and M_2, were being tested at a frequency of 107, it was observed that when the current as read by D was 44·8 amperes, W_1 indicated 310 watts, and W_2 indicated 290 watts. In this particular experiment M_1 was on the mains at 100 volts, and was used as a step-down transformer, the volts on the primary of M_2 being greater than 100 volts. While, therefore, $44·8 \times 100$ watts were being returned to the mains by M_1, the thick coil of transformer M_2 was being supplied with $4,480 + 310 + 290$ watts. The load on the step-up transformers was thus 5,080 watts. The total loss in the two transformers is, however, less than 600 watts, since there is a considerable loss in the leads and dynamometers, etc. The loss in the leads at 44·8 amperes is 63 watts. The thin coil of W_1 was used in this particular test, so that an additional loss of 89 watts must be allowed for. No extra allowance has to be made for D, as the thick coil was used, and the loss in this coil is already taken into account in estimating the loss in the leads. The total loss in the testing apparatus for this current is, therefore, 152 watts, and the total loss in the transformers is thus $600 - 152 = 448$ watts. The joint efficiency at this load of 5,080 watts is, therefore, $1 - \frac{448}{5,080} = 1 - ·0883$

= 91·18 per cent. This number is the product of the efficiencies of the two transformers, and, if these are assumed to be equal, the true efficiency is obtained by taking the square root of 0·9118 giving 95·5 per cent. Also if the copper losses at this current, determined by the method already described, be subtracted from the total loss of 448 watts, we obtain 275 watts as the iron losses at this load. This only differs by 15 watts from the actual reading of W_2.

This process has been gone through for each of the efficiency determinations made; but in order to simplify the work, curves have been plotted denoting respectively the losses in the leads, in the transformer coils, the total losses in leads and transformers, the total losses in the transformers, the losses in the core, and the corresponding power supplied by the mains and measured by W_2.

The curves shown in Fig. 2 indicate a complete set of observations made on the two large Mordey transformers, M_1 and M_2. As many as 30 such sets were taken in connection with different combinations of the transformers. Several of these had to be rejected from various causes. For instance, it was at first arranged, by means of a combination of switches, to make one wattmeter do the work of the instruments W_1 and W_2, but after several measurements had been taken it was found that the alteration of the resistance of the circuit caused by the introduction of the wattmeter coil altered the currents flowing to a serious extent. The majority of the tests, however, confirmed each other in a very satisfactory manner. It is unnecessary to give the details of all the measurements, and we shall, therefore, merely give the numbers denoting the losses at different loads. These losses are interpolated from the curves drawn through the actually plotted points. The following table shows the results obtained from five sets of observations at various frequencies on the two large transformers, M_1 and M_2:

Combined Losses in Two 4½-Kilowatt Transformers of the Mordey Type.

Load in watts.	Approximate frequency in periods per second. Loss in watts in the two transformers.		
	100	120	160
1,000	292	270	229
2,000	305	280	241
3,000	335	[illegible]	275
4,000	375	345	320
4,500	400	—	—
5,000	425	—	—

From these numbers we obtain the following values for the efficiency of each of these two transformers:

Load in watts.	Approximate frequency in periods per second. Efficiency of each transformer.		
	100	120	160
1,000	84·46	85·59	[illegible]
[illegible]	92·19	92·76	[illegible]
3,000	94·27	94·79	[illegible]
4,000	95·22	[illegible]	[illegible]
4,500	95·46	—	—
5,000	95·76	—	—

From these numbers it follows: 1. That the greater the frequency the higher the efficiency for any particular load. 2. That the greater the load the higher the efficiency for the same frequency. Both these results follow, of course, from the fact that the iron losses are the same at all loads for a given frequency, and diminish as the frequency increases. And they do not, for these particular transformers at any rate, confirm the results referred to at the commencement of this paper that the efficiency is a maximum at the frequency of 100.

The open-circuit losses expressed as percentages of full load are 3·2 per cent., 2·8 per cent., and 2·36 per cent. at frequencies of 100, 120, and 160 periods per second. If the iron losses be constant for all loads at a given frequency it can easily be proved that the efficiency of a transformer must be a maximum when the copper losses become equal to the iron losses. And calculation shows that, for these two 4½-kilowatt transformers of the Mordey type, this equality will occur at a load of 7,200 watts at a frequency of 100, at a load of 5,500 watts at a frequency of 160, and at a load of 5,000 watts at a frequency of 200 periods per second when the maximum efficiencies become 96 per cent., 96·1 per cent., and 96·3 per cent. respectively. There is, therefore, no great difference between the maximum efficiencies at different frequencies, but the higher the frequency the lower the load at which the maximum of efficiency occurs.

The following table summarises the results obtained from the tests of the 3,000-watt, M_3, and the 4,500-watt, M_1, transformers of the Mordey type combined.

Load in watts.	Frequency in periods per second. Loss in watts in the two transformers.		
	107	160	200
0	235	185	175
3,000	320	265	255
4,000	410	340	[illegible]

From these numbers we obtain the following values for the joint efficiencies of these two transformers:

Load in watts.	Frequency in periods per second. Joint efficiency of the two transformers.		
	107	160	200
3,000	[illegible]	91·17	91·60
4,000	89·75	91·50	90·88

Now from the former tests we know the efficiency of M_1 at these loads and at two of the frequencies. We can thus obtain, by division, the efficiency of M_3, as follows:

Load in watts.	Frequency in periods per second. Efficiency of transformer M_3.	
	107	160
3,000	94·76	95·66
4,000	94·25	[illegible]

The efficiency of the small 1,500-watt transformer, M_4, of the Mordey type was tested at a frequency of 150 and found to be 90·2 per cent., at a load of 1,500 watts, and higher at a larger output. The method used in testing this transformer is of some interest, arising from the fact that, as already stated, this transformer was for special experimental reasons so wound that it transformed from 100 volts to 100 volts. Now, when the change ratio of a transformer is unity, it is not necessary to employ another similar transformer when using our method of testing the losses directly, since the primary and secondary coils can be employed, one to take energy from the mains and the other to give back what is not lost in the transformation. Of course, an auxiliary transformer (C, Fig. 1) must be employed, but the two transformers, A and B, in the figure are replaced with the single-unity-change-ratio-transformer, M_4.

As the large transformers of the Mordey type are wound with two thick wire coils in addition to the fine wire one, in order that the transformers may, if required, be used on the three-wire system, it is possible to measure the efficiency by the method last described with the employment of a second similar transformer. And tests that we made in this way confirmed those previously carried out.

But, as the fine wire coil of the transformer is not used, this method, although excellent for a transformer whose change ratio is unity, is not to be recommended for one which transforms from 50 or 100 to 2,000 volts. Indeed, it is obvious that if the test be made in the way just described, the advantage of dispensing with the duplicate transformer is counterbalanced by the fact that the transformer tested can only be used at what is practically half load, and the copper losses are therefore proportionately greater than when the transformer is used in the ordinary way at full load. Employing, therefore, two similar transformers as well as a small auxiliary transformer, as in Fig. 1, is much to be preferred.

A large number of tests were made by combining the Hedgehog transformer, H, with M_1 and with M_3, and, although the results (as already mentioned) were not as

satisfactory as when two Mordey type of transformers were employed, they were sufficiently accurate to show that neither at no load nor at full load is there any great difference, apparently, between the power wasted in a Hedgehog and in a Mordey type of transformer of the same output. On this point, however, we shall say more when we have had more time to analyse the results we have already obtained with the Hedgehog transformer.

In conclusion, we wish to express our thanks to the Brush Company for so kindly lending us the two 4½-kilowatt transformers, and also our obligations to several students at the Central Institution, and more especially to Messrs. Baillie, Baylay, and Clift for their interest and energy in carrying out the experiments, and in reducing the results.

Lamp Trimming.—Safety bicycles are now being introduced in America for the lamp trimmers to make their rounds more quickly.

STEAM AND GAS ENGINES AT THE CRYSTAL PALACE.

Among the engines which were present in the largest numbers were the Crossley Otto engines, of the more usual and of the special high-speed types, and the Stockport engines of various sizes and forms. Of the former, we give herewith a perspective view, Fig. 1, as this engine is specially designed to run at the high speed from which the desirably uniform speed required for driving dynamos is more certainly obtained than with the lower speed. Another advantage obtained by the use of the high speed engine is a smaller difference between the size of the flywheel and the pulley on the dynamo, thus securing better running of the belt with smaller tension upon it. In this engine every refinement which Messrs. Crossley Bros. have brought out is employed, including the timing valve for ensuring regularity of ignitions in the heated tube, and the governor made so that within certain limits the engine may be made to run

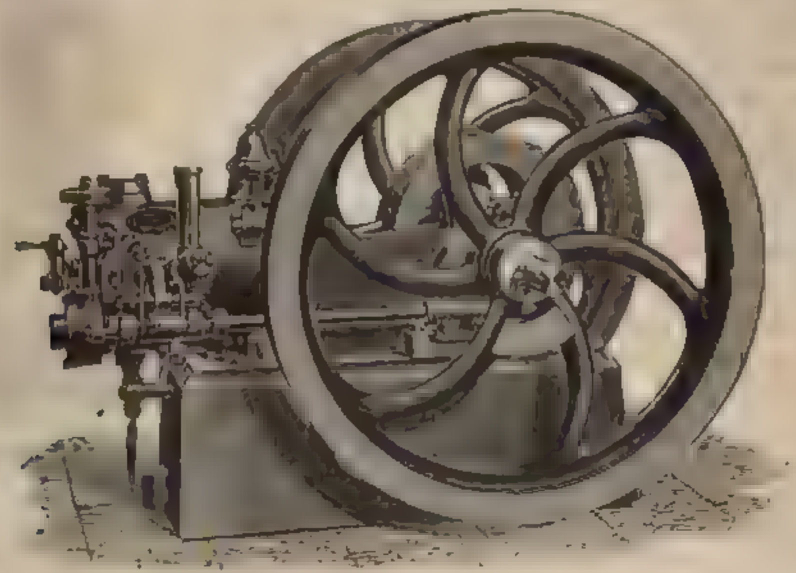


Fig. 1.

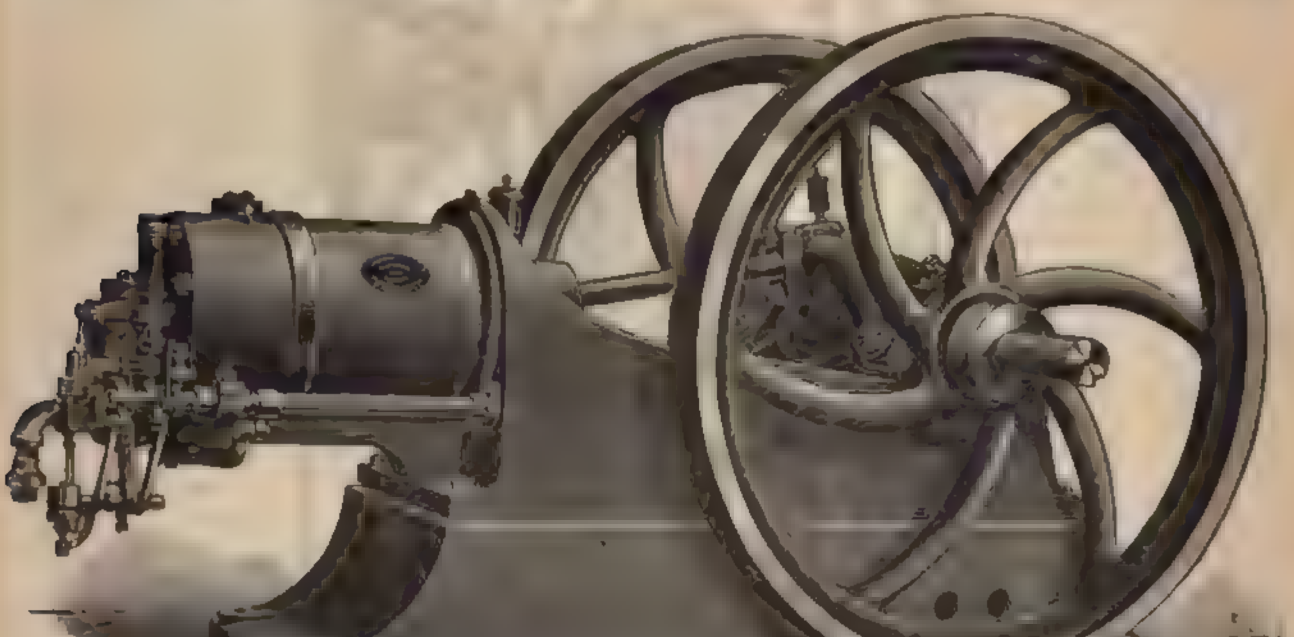


Fig. 2.

at any desired speed. The engine being constructed on the Otto principle is, of course, single-acting, and great care has been taken in balancing the reciprocating parts, the balancing weights being so placed that they move at the same mean velocity as the parts to be balanced. Messrs. Crossley Bros. are fitting their larger engines with self-starters, and they exhibited several other forms of their engines, including the vertical, and all were of the highest class of design, workmanship, and finish.

The Stockport engines exhibited by Messrs. J. E. H. Andrews and Co. were of several forms and two kinds—namely, the double-cylinder or displacer cylinder Stockport engine, and the newer Stockport Otto engine, the latter being made both in the horizontal and vertical forms, as shown in Figs. 2 and 3. Fig. 2 shows the engine as fitted with the makers' timing ignition valve, and with their self-starting apparatus. By means of the timing valve the ignition is prevented from taking place until the crank is past the centre in the position for working in the proper direction. It may be mentioned that the Morecambe Electric Light Company is using three of the large engines as shown in Fig. 2 for its central station, the engines being of 16 nominal horse-power, and have to give current to about 1,000 16-candle lamps. The self-starter used on these engines is of a very simple character. A small gas inlet cock is placed in connection with the port which usually allows the exhaust gases to escape. The exhaust valve is for the time prevented

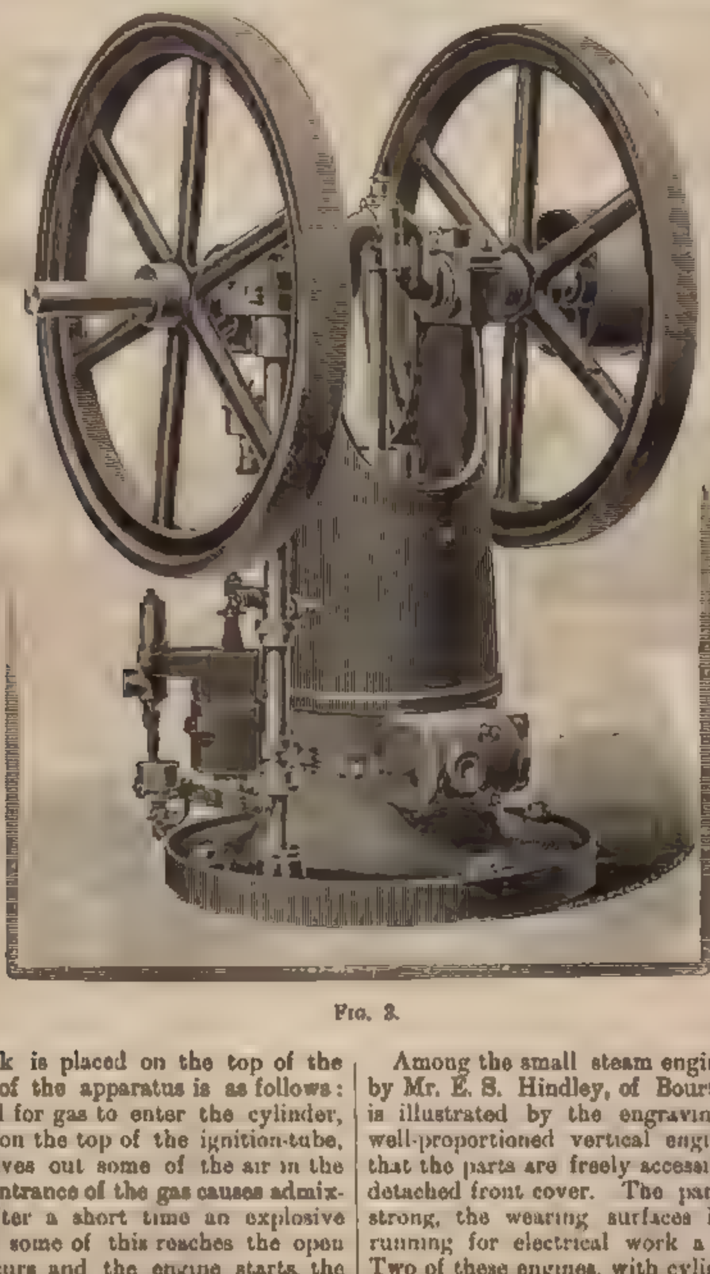


Fig. 3.

from acting. Another cock is placed on the top of the ignition-tube. The action of the apparatus is as follows: The gas-cock being opened for gas to enter the cylinder, and the cock being opened on the top of the ignition-tube, the entrance of the gas drives out some of the air in the cylinder. The continued entrance of the gas causes admixture of gas and air, and after a short time an explosive mixture is formed. When some of this reaches the open ignition-tube explosion occurs and the engine starts, the special gas admission cock and the emission cock on the ignition-tube being simultaneously closed by the pressure which follows the explosion. Self-starting gear is of great importance in connection with the use of the larger gas engines, and they add very considerably to the size of the engines, which can be conveniently handled.

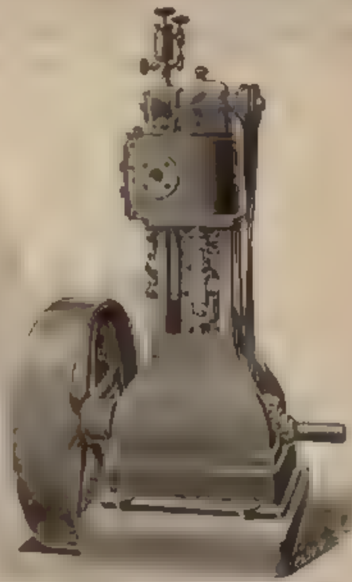


Fig. 4.

Among the small steam engines exhibited were several by Mr. E. S. Hindley, of Bourton, Dorset. One of these is illustrated by the engraving (Fig. 4). It is a neat, well-proportioned vertical engine, with a frame so made that the parts are freely accessible by removing an easily detached front cover. The parts of the engine are very strong, the wearing surfaces large, and for high speed running for electrical work a special governor is fitted. Two of these engines, with cylinders 7in. diameter and 7in. stroke, were employed in driving several machines at the Palace, and they worked very satisfactorily.

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ELECTRICITY AND THE MEDICAL PROFESSION.

This is the title of an article of which the editor of our esteemed contemporary the *Electrical Review* forwards us an advance proof. It is not our custom to criticise the words or views of our contemporaries, but in this case we feel that the full influence of all technical electrical papers should be given, if only to assure the general public we are of one mind as to the true value of apparatus which can only go to form the stock-in-trade of quacks and charlatans. Our contemporary has long carried on a crusade against the curative properties of a "Harness belt." We have all along felt that such a crusade partakes of the nature of a hopeless struggle. The readers of technical papers do not buy magnetic belts, magnetic boots, or magnetic hair brushes. They have, as a rule, enough moving in a magnetic field without resort to these extraneous aids even if they believed in them, which they do not. While papers of a general character are so easily bought and sold by advertisments, and while testimonials frankly given are so easily obtained, and while doctors themselves testify generally rather than specifically, so long will quackery and charlatanism prosper. Our contemporary's article is based upon a pamphlet entitled "The Treatment of Disease by the Prolonged Application of Currents of Electricity of Low Power, being an extract from the latest edition of 'Massage, Electricity, and Allied Methods of Treatment,'" by Herbert Tibbits, M.D. We also received a copy of this pamphlet and an invitation to visit the "Electropathic and Zander Institute," but had no intention of noticing the one or visiting the other. That some very divergent opinions obtain as regards electricity and the human body we well know, but we are surprised to learn that any divergent opinion obtains about Harness's electropathic belt. Let us at once acknowledge, which we believe is a fact, that at the Zander Institute will be found some excellent specimens of electrical and other apparatus, much of which may be beneficial if used properly by weak humanity. As we take it, our contemporary is not protesting against anything but the trading upon an ignorant but superstitious and believing public in order to sell apparatus which has little to recommend it except "faith." Dr. Tibbits, for example, testifies to having tested Mr. Harness's electrical appliances, and contends to have proved that "these experiments prove conclusively that a current of electricity penetrated the skin and influenced the subjacent tissue." The galvanometric deflections were obtained by pricking the skin; but, as our comtemporary points out, the ordinary belts "are not furnished with platinum needle points one-third of an inch long for the purpose of puncturing the skin." An infinitesimal current obtained by such puncturing does not mean even an infinitesimal current without such puncturing. How, in the name of common sense, is the body, or any part of the body, brought into the circuit when using the ordinary magnetic belt? We have heard a good deal about the curative properties of electricity, but with this we have nothing to do. We want to know something of the curative properties of a weak—very weak, if any—magnetic field. Let us drop the

idea of "current," because there is no current, while if the belt itself gives a feeble current there will be around it a current-field or a magnetic field due to the current in the conductor. It is this field we usually have to talk about, and what does Dr. Tibbits or Mr. Harness know about it, or its properties? They tell us nothing about it, hence we take it for granted that they do not understand much about the apparatus they use and talk about so glibly.

THREE YEARS' HIRE SYSTEM.

It is tolerably certain that almost all electrical firms and companies are troubled with symptoms of impecuniosity, and to ask them to embark in a venture that requires a large capital is a bold undertaking. Nevertheless we have to commend to their notice an old, a well-tried, and a successful system known as the hire-purchase system. No doubt in many minds this system is almost entirely associated with the getting of pianos, but business men know that it largely permeates through all businesses. The engine builder is not above taking a leaf out of other folks' experience, and many of the highest firms are paid by instalments, and glad to do business in that manner. If the engine builders can do this, the dynamo builders will have to follow suit, and especially those who are going to pay particular attention to motor work. In the first place, we must assume that good motors can be obtained whether for direct or for alternate current. The amazement is that one or other of the existing big firms have not long since caught on the idea and pushed it as vigorously as we know they can push business which promises good returns. Harking back once more to central station work and constant load, the aim of the management is to sell all the current possible—in fact, we all aim at making money. With the spread of mains there must be hundreds of adjacent premises wherein motors could be put to good use, either for new purposes or replacing old steam engines or gas engines. Numbers of men in a small way of business cannot see their way to get rid of an old engine. It does its work, and they cannot spare the money to replace it by a motor, though they would make an effort to pay for the motor by instalments. We are perfectly certain that though electricity is in one way much dearer than coal or gas, in a large percentage of cases the ultimate bill to the user would be lower than when using either steam or gas. Users have not yet realised the enormous advantages gained in space, in cleanliness, and, above all, in not paying for power except when using it. The switch that turns on the current is also used to turn it off. No electrical energy is paid for when the switch is off, and it is here the gain comes in. With steam or gas, coal and gas and water are always being used. Further, we are under the impression that an electric motor will not deteriorate with age and use so much as a steam or gas engine. However, it is little use to discuss such questions here. From information received—as the police say—it would seem that the adoption of the hire-purchase system would bring grist to the mill. Rumours are rife that the "City" is to be made acquainted with a company having this object in view, but we fancy the industry has been sufficiently cursed with promotion-money, and that existing firms may well develop the business themselves.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC LIGHT AND POWER.

SIR,—I am obliged to Mr. Shippey for the valuable information given by him in his letter to you of the 15th inst. respecting the date of the production of the first arc light. I agree with him that there were other experimentalists in the field whose names ought not to be overlooked as pioneers in electric lighting. I thought it right to date the birth of the electric arc light from the *first public occasion* on which it was seen. I did not record other names for the simple reason that the historical sketch is made very brief and general, and any further reference or extension would be out of place. I afterwards found that I had made a mistake respecting the "Grove" cell, which will be corrected. With Mr. Shippey's kind permission I should be glad, when bringing my articles out in book form (of which those given in the *Electrical Engineer* will only form a part), to insert his remarks respecting the early workers, for the benefit of those who may be interested in historical records of electricity.—Yours, etc.,

Sept. 21, 1892. ARTHUR F. GUY.

SIR,—The science of electricity owes so much to the science of chemistry that it is scarcely fair of electricians to base their arguments—even inadvertently—upon erroneous chemical data. Hence I feel it incumbent upon me to call in question a few of the statements used by Mr. Arthur F. Guy in his paper under the above title. Let us, for example, analyse the very first sentence of the article on "Evolution of Electrical Engineering," appearing in your issue of September 16. It runs thus: "A pure and healthy atmosphere is dependent upon the amount of oxygen present . . ." To use the author's own words in a later clause, "this is a *very great* mistake." The true facts of the case may be stated thus: After the researches of Priestley and Lavoisier it was fully recognised that oxygen was the great supporter of life and combustion, and that the chief function of nitrogen was to keep its action within proper limits. Then it was thought that the great secret of health had been discovered, and that air was wholesome in proportion to the amount of oxygen it contained. But this theory has long been exploded, since it has been shown that the variation in the percentage of oxygen in good and bad air is extremely slight. This subject was thoroughly investigated by Dr. Angus Smith. From a great number of analyses this experimenter found that the *extreme* variations in the percentage of oxygen in atmospheric air were 20·99 per cent. (by volume) in a sample of air from the Scotch moors, and 20·63 per cent. in air collected from the gallery of a London theatre (where gas was the illuminant) near the close of the performance. Thus, although it is true that expired air contains about 4 or 5 per cent. less oxygen and about 4 per cent. more carbonic acid gas than inspired air, yet the percentage of oxygen in air remains almost stationary even under the severest tests. May I be allowed to ask *en passant* what distinction Mr. Guy places between "all substances" and "matter"; and whether the terms "chemical combining" and "mixing" are used as synonymous or alternative? But now we are told that "the volume of the new gas thus given off is often poisonous"—that is to say, a burning candle, or gas jet, or oil lamp continually produces a "poisonous volume." Poor innocent candle: how we should dread thy flickering flame, so wrapt is it in "poisonous volumes" of its own invention! To continue: "All three vitiate the atmosphere and give off poisonous fumes, the carbon which they contain mixing (*sic*) with the oxygen from the air, and so producing the

deadly carbonic acid gas. . . ." Of this *deadly* gas an ordinary man gives off more than 400 litres per diem; that is to say, produces at least 90 gallons every 24 hours. Ninety gallons per day of this "deadly" gas "known to chemists as carbon dioxide"! The wording of the sentence seems to hint that the very chemical name itself signifies death. It is plainly evident that some electrical contrivance ought to take the place of our excessively dangerous organs of respiration. No wonder that our poets allude so pathetically to human sighs. The woe that causes a deep sigh is dwarfed into insignificance beside the calamity with which such a death scattering sound is fraught. I should like to point out that soda-water, champagne, and other effervescing drinks simply reek with this deadly carbon dioxide. No doubt the author avoids all so-called sparkling wines for this reason.

But let us come down to *facts*. Roscoe and Shorlemmer, in their first volume of "A Treatise on Chemistry," sum up the character of our venomous enemy—carbon dioxide—in these words: "At the same time, however, it does not exert a poisonous action on the animal economy, as, indeed, may be gathered from the fact that it is constantly taken into the lungs and emitted from them; . . ." So, then, carbon dioxide is simply a sheep in wolf's clothing, dressed up for the occasion of its formal introduction to the electrical world. Let me remind Mr. Guy that it is the carbon dioxide *from our own lungs* which is so impregnated with "deadly" properties, and not that given out by the innocent little night-light. In reply to the statement that "there can be no light without heat," I would suggest the case known as phosphorescence.

Next we learn that "in the case of an electric incandescent light the small amount of heat evolved from it is due to the *high temperature* of the lamp filament, and on account of the *vacuum* in the lamp there is no conducting medium for the heat." (The italics are our own.) From this we gather that *a high temperature* is very prejudicial to the production of heat, and that radiation in a vacuum is impossible. The temperature of the sun is so great, and the vacuum between the earth and the sun so vast, that no heat can reach us from that source. May I quote Prof. Balfour Stewart: "Radiation of heat takes place in vacuo as well as in air; for it takes place between the sun and the earth, and between the fixed stars and the earth, and we have no reason to think that all space is filled with some kind of air."

The conflicting statements "that the insurance companies look upon its (electric light) introduction with favour," and that the insurance people have had to draw up very drastic rules in order to protect themselves, need no comment. But, Sir, I have already overstepped the narrow limits of a correspondence column, so with a word I will conclude. If we are to convince the public of the undoubtable precedence of the electric light to all other methods of illumination, we must be quite sure of the grounds of our arguments. To electricians the expression "the public" is a phrase which includes all investigators in *other* sciences, so that our *pros.* and *cons* on the subject of lighting must commend themselves to our contemporary scientists. As an old college friend of the author—whose paper I have dared to criticise—I know I can rely upon Mr. Guy's sympathy with my remarks, although perhaps I have rather warmed up to the discussion. But Mr Guy confesses that there is "no light without heat"; so if I have succeeded in throwing light upon the subject—as, indeed, I hope I have—then heat must accompany my remarks.

Screening myself upon the grounds that the author only "reserves all rights," and that I have questioned those parts which do not to my mind fall under that title—Yours, etc., A. E. RICHARDSON.

High School, Dorking, Sept. 19, 1892.

SIR,—I find on reading over my letter sent to you upon the above subject, and which appeared in your last issue, that a slight mistake in names has occurred in copying my manuscript, and probably to those interested in searching up historical electrical work the name of Izarus's, as stated, would be unknown, and probably cause confusion under these circumstances. I will thank you to correct this part of my letter, which should read: "Izarn's 'Manuel du Galvanisme,'" a work which was published in the year 1805, and from which work I discovered the information published by you; and at the same time I shall be glad if you will also add, after "more ancient school," the following words: "*the idea of the storage of electricity.*" By inserting these few words which were omitted by my clerk, the purport of my letter will be better understood and appreciated by those interested in the fundamental work relating to the battery industry and storage of electricity.

Apologising for intruding on your space,—Yours, etc.,

ARTHUR SHIPPEY.

ON THE MANUFACTURE OF INCANDESCENT ELECTRIC LAMPS.

BY FREDERICK GRAHAM ANSELL, F.C.S.

The manufacture of incandescent electric lamps, although apparently very simple, is in reality a matter of some difficulty, and requires a great amount of care besides a sound knowledge of chemistry and general physics. It will be my endeavour to treat the subject as simply, but at the same time as thoroughly, as possible in these pages, so that the process of manufacture shall be perfectly clear. However, I shall say little or nothing of the glass-blowing, except that it is usual to make the bulbs from glass tubing, and that they are generally made to gauge. Glass-blowing, however, is a separate trade, and to be understood properly must be seen and learnt.

The principal difficulties in making an incandescent electric lamp are, first to make the filament, and then to preserve it. Many experiments have been made to discover the best material from which to prepare the filament, which is invariably the purest carbon that can be obtained. Some experimenters have tried platinum, iridium, osmium, and various alloys with high melting points, but the difficulty always has been to regulate the current so as to give a good light, but at the same time so as to prevent the fusion of the wire, the temperature of incandescence always being so very near the melting point. Consequently metal filaments have all been abandoned in favour of carbon, which, so far as we know at present, has no melting point, although it seems to volatilise and to break if subjected to a current of electricity much in excess of that required to make it brilliant. This apparent volatilisation is best observed in lamps which have been in ordinary use a long while, when it may be noticed that a very thin coating of carbon is deposited upon the inside of the glass.

Several methods have been tried for preparing the carbon filament, some deriving it from paper, some from bamboo, and some from cotton, but, in 1883, Mr. Swan took out a patent for preparing his filaments by an ingenious chemical process from gun-cotton or nitro-cellulose. He takes a solution of nitro-cellulose in, say, acetic acid, and forces it through a die into alcohol of 70 per cent. or 80 per cent. strength. The alcohol sets the thread as it issues from the die, and consequently the thread can be made to assume any desired form of cross-section; but in this state it would still be explosive, so, therefore, it must be treated with hydrosulphide of ammonium, or other suitable deoxidising agent, until it loses the power of burning explosively, when it can be washed, dried, shaped, and carbonised.

I will now fully describe one good method of preparing the filament, and will take as a basis of the operation the purest white crochet cotton I can buy at an ordinary linendraper's shop. Firstly, the skein must be thoroughly washed in clean cold water by agitation, and then boiled to remove the size or other dressing put in by the spinner. It is then to be dried and wound loosely on to square frames made of four round glass rods or small tubes, in such a manner that no two turns of the cotton shall touch each other.

Each free length of cotton must be a little longer than the filament it is designed for. The above frame shows cotton enough for 14 finished filaments, and must now be taken by its two glass hooks or handles, C C, and suspended carefully in a solution consisting of two parts sulphuric acid of specific gravity 1·845, and one part of clean cold water. In making this mixture considerable heat will be

developed, therefore it must be made some hours before it is wanted, so that it may cool down to 60deg. F. before it is used. Whilst it is cooling it will probably throw down a white sediment, and if so the supernatant liquid must be carefully drawn off by means of a syphon. Too much attention cannot be paid to this solution, as a very slight deviation from the proper proportions of water and acid, or from the proper temperature, will render it quite useless for its intended purpose. Nothing but glass and the cotton should be allowed to touch this liquid, which is very corrosive. The cotton will not have to remain in the solution very long, but it must be put in and taken out very gently and must be carefully watched whilst there. It will soon become coated with a transparent gelatinous substance — cellulose. This transformation must be stopped just as the last traces of the strands of the cotton begin to disappear by quickly but gently lifting the cotton out of the acid and plunging it gently into a large quantity of clean cold water. The cotton has now swelled considerably and drawn itself more tightly across the frame. The frame must now be suspended by its hooks for some hours in a gentle stream of clean cold water so that it may be thoroughly washed, but no amount of washing will remove the last traces of the acid, therefore the frame and its cotton must be dipped for an hour or so in a very weak solution of ammonia of about 1 per cent. strength. This will neutralise the acid, and a little further washing in the above stream of clean cold water will make the (I must still call it) cotton fit for the next operation—viz., shaping the filament—which presents no difficulty, the prepared cotton being taken from the water and, whilst still wet, made to assume the form it is intended to make the finished filament. This is most easily effected by winding the cotton over glass tubes suitably arranged in a frame, but some people have used carbon blocks.

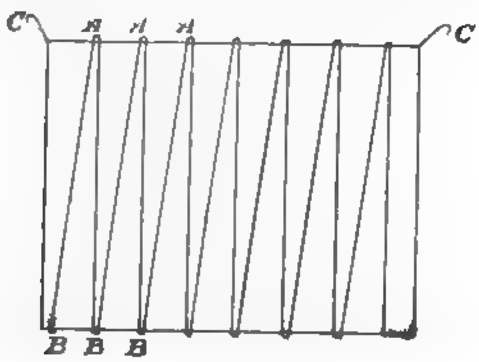

FIG. 1.

The frame or block must in any case be so arranged that each free length of cotton as at A B, Fig. 1, shall be used for one separate filament, and the cotton cut at the place where it passes the tubes from which it is stretched, and which it touched whilst in the acid solution. This precaution is to ensure the filament when finished having the same appearance through its entire length. Any form can be given to the cotton, and when dry it will retain it, but its qualities are now very different from those of the original crochet cotton, it being stiffer and harder, while its breaking strain is much greater. These qualities will afford a fair indication of whether the dipping operations have been properly conducted.

The next process is to coke or carbonise this prepared thread, a process which is easily performed, although it requires considerable care. If we used the former of the two plans for forming or shaping the filament, then these must be cut from the glass tubes and put one by one into an iron box with powdered charcoal sprinkled on the bottom. More charcoal will now be sprinkled on until these filaments are covered, when another layer of filaments can be put in, and so on until the box is nearly full, when at least half an inch of powdered charcoal should be laid on, and then the closely-fitting lid. I believe this plan is generally found better than that of the blocks (although these can, of course, be packed in the box along with the powder), because the carbonisation shrinks the prepared cotton, and, consequently, it is apt to break in irregular places. I have heard, however, of a proposition to put a knife-edge along the carbon block at the place where it is desired to break the prepared cotton. Personally, I like the first plan best, as it seems to me simpler and more certain. The iron box is now to be put into a muffle and gently warmed, in order to expel as much air as possible, and then brought to a good white heat, which must be maintained for some little time—sufficient to allow the whole contents of the box to be brought to the same temperature. This time depends, of course, a good deal upon the size of the box and the heat of the furnace. The box with its contents must now be allowed to cool in the furnace so that no air can enter, or the filaments will be found rotten. The box having become thoroughly cool, the lid may be removed and the contents gently turned out a little at a time on to a very coarse or open sieve, say, with ¼in. meshes, and this being gently shaken, the filaments will remain on the sieve whilst the carbon powder passes through. The filaments should now appear of a good dull black, and be somewhat springy; these two qualities should of course be found throughout the entire length of each filament. If, however, they appear very glossy, it is generally a sign that they have not been sufficiently heated, and in consequence are not properly coked, but if they are irregular in thickness or variously glossy and dull, they may be considered spoiled either from admission of air into the box, the presence of some mineral matter, or insufficient heat. In either case they are no good, and should be thrown away at once.

We have now the carbon basis of our filament, and

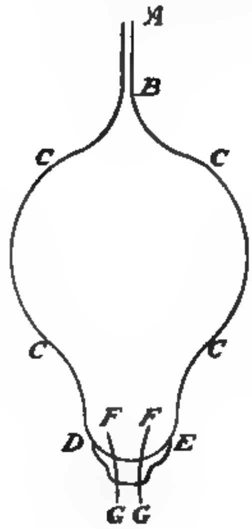

FIG. 2.


FIG. 3.

having laid it on a metal gauge and snapped off the protruding ends to make it the right length, we proceed to mount it on the two little platinum wires passing through the globes, the ends of them having been flattened by a blow from a small hammer, and then bent round so as to form a conical opening into which a little "paste" has been introduced. The filament must be handled very carefully, because in its present state it is very fragile, but it is strong enough to be taken in the finger and thumb and pushed into the "paste." It is then to be put into a warm place to dry slowly but thoroughly. The "paste" is usually made of very finely-ground charcoal and coarse moist sugar with a little distilled water. Sometimes a small proportion of finely-ground plumbago is added. The sugar is added in just sufficient quantity to make the particles of carbon adhere firmly together, and I am constrained to think that the fineness to which the carbon and plumbago are ground in the first instance is a very great factor in the efficiency of the "paste" or "cement." It should be prepared in small quantities at a time and used as fresh as possible. I have tried treacle and turpentine instead of sugar, but did not find them answer the purpose so well. I am told that starch has been used with good results.

I would just mention, by way of explanation, that it is usual, in making the external parts of the lamp, to blow the globe from a fairly large tube, and then having melted glass beads on to the short lengths of platinum leading-in wires to melt these into the bottom of the neck of the globe. A good firm joint must be made here to prevent

air entering after the lamp is finished, so the glass should be well melted on to the wires for quite half an inch, and if necessary can be easily pinched together whilst hot. This being done, and the small tube, A B, having been melted on to the globe, C, the neck, D E, is left ready for the platinum leading in wires, F G, with their glass mounting, as shown.

It is very necessary that all the glass used in any one lamp should come from the same glass house, and if possible from the same pot, as glass of different makes cannot be efficiently joined together.

We will now return to our filament, which is mounted on the platinum wires, as at Fig 3, and found dry. The next operation is known as flashing, and its object is to coat the carbon filament with a thin layer of very hard compact carbon, and so to reduce its initial resistance, which is always very high, to almost any desired amount. There are several ways of doing this, but they are all very similar. In each, the platinum wires leading to the filament should be connected to the terminals of a dynamo machine capable of giving 100 to 150 volts E.M.F., as shown in Fig. 4. Not less than 150 volts should be the figure if it is intended to make the usual 16 c.p. lamps. The filament must now be put vertically into a strong glass vessel, and the air must all be got out.

I will suppose that we are going to flash the filament in ordinary coal gas as it is supplied by the gas companies for lighting. Place a wide-mouthed glass bottle bottom upwards on a suitable stand, procure a well-fitting bung, perforated for two small tubes, and with two wires passing through in the middle, as shown in Fig. 4. Connect the gas-pipe by means of a short piece of indiarubber tube to one of the glass tubes passing through the bung. The other glass tube passing through the bung should be drawn to a small opening at the outer end. The gas may now be turned on, and when sufficient time has been allowed for

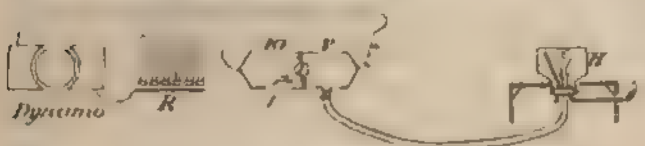

Fig. 4.

the air to be driven out, a flame should be lit at the small orifice. Great care must be exercised to ascertain that all the air is out or an explosion might ensue. It is advisable to have a well fitting bung, and only to put it lightly in the neck of the bottle in case of accidents, but in addition to this it is a good plan to get a penny chemist's test tube, hold it inverted over the nozzle, so as to collect the emanating gas, and then to take it a few yards away (still inverted), and to present it to a flame. If an explosion occurs in it you may know that the large bottle would explode violently, but if the gas only takes fire, and the little blue flame goes gently up to the bottom of the test tube, then there will be no fear of an explosion. The whole arrangement is shown in Fig. 4.

The glass jar being free from air and the filament being arranged as one arm of a Wheatstone's bridge, as shown, and the circuit being easily under control, the current may be turned on and regulated by the resistance coils, R. The galvanometer must now be closely watched, and the very instant the resistance of the filament has fallen to the desired figure the current must be stopped or the filament resistance will be too low—a fault which cannot be remedied. The above sketch shows all the necessary electrical connections, the path of the current being from the dynamo, which should be shunt wound, through the resistance coils, R, which should be about 10 to 25 in number, and of about 10 ohms each, in German silver wire; it then goes to the Wheatstone bridge, one side of which has very high resistances and the other side very low. A good arrangement would be for the top side to have, say, 10 ohms as a fixed resistance and an ordinary box of adjustable resistances, V, varying from 500 to 2,000, while on the other side we might put one ohm for one arm and the filament for the other. The galvanometer should have 1,000 ohms resistance, and should be connected through a spring key. Suppose we wish to make a filament of 150 ohms resistance, then we must arrange the above bridge with its 10 ohms and 1,500 ohms on one side, because 10 : 1,500 :: 1 : 150, i.e., the filament. To flash properly and quickly will require some practice, and a good manipulator need not allow the needle of the galvanometer to swing more than 2deg. or 3deg. In the above arrangement the resistance of 150 ohms for the filament is reached when it is impossible to move the needle of the galvanometer by depressing its key.

When the current is first turned on, probably all the force of the machine will be required to bring the filament to a white heat, but then the deposition of carbon from the gas would be so rapid that it would be impossible to arrest the process at the right time by means of the "bridge" and a simple switch, therefore the resistance coils, R, are inserted into the circuit, so that the temperature of the filament, and, consequently, the rate of deposition of carbon from the gas, may be kept fairly constant by adding resistance to the circuit at any desired speed by simply moving a short contact piece.

On removing the filament from the glass bottle, H, it will be observed to have a grey or steel coloured appearance, but I have never found this very pronounced on filaments flashed in coal gas. However, for sale purposes this appearance is much valued, and consequently some factories have to flash twice, the second time being in an atmosphere of benzene vapour. Personally I am not in favour of this double flashing, as I have flashed continuously in benzene, and have invariably obtained good results at one operation. Therefore I should recommend that gas, with its attendant dangers, be altogether discarded, and benzene adopted in its place, the small extra expense for the difference in the flashing apparatus being more than counterbalanced by the ease in working and by the results.

(To be continued.)

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.*

BY PROF. GEORGE FORBES.

LECTURE II.

(Continued from page 290.)

Now we come to the question of high pressure supply. It was perfectly obvious, from the earliest attempts at distribution, that we should lose very considerably if we tried to extend low pressure to any great distances, and the obvious remedy for the difficulty lay in using high pressure, which involves smaller wires at any rate. The old attempts that were made were of two kinds. The first attempt was by means of storage batteries; and in my previous Cantor lectures I was able to give you an account of a great attempt that had been made to introduce such a system at Colchester. The scheme died from various causes among others, that the batteries which were employed were not thoroughly reliable. An exactly similar scheme has since been worked out in Chelsea by the engineers who superintended the Colchester system; we have there an example of storage batteries, put into sub-stations, which are charged all in series by high-tension mains, and which discharge into the houses by independent low-pressure mains. That system is one which we can see now, as the result of some time of working, is satisfactory in many ways, the only serious objection being probably its cost. That is the only case of that sort which has been before us, and is one which interests us very much, as being a development we would wish to see thoroughly successful. The other attempts directed towards a system of parallel-series made in previous days were all distribution, as we have called it. The lamps and mains were divided into groups, the lamps of each group being put in parallel, and the successive groups put in series. So, it would be possible to have a dynamo working at 400 volts, with five main wires in the distribution network, the lamps being placed between the first and the second, the second and the third, and the third and the fourth. There would be thus four groups of lamps, which would be in series

* Cantor Lectures delivered before the Society of Arts.

with each other, each group only taking its hundred volts, while the dynamo would be giving 400 volts, and we should be thus able to go four times the distance that we should with the ordinary two-wire system, or to twice the distance that we could with a three-wire system of 200 volts. This system has been adopted in several cases abroad; even at the time of my previous lectures it had been used for some time in Hungary, at Temesvar. It has been since then more extensively introduced by one or two central stations, the most notable one being the Secteur Clichy, in Paris. The difficulty with this system of distribution lies in the fact that when at any time of the day the number of lamps upon the different groups is not equal, the groups which have the fewest lamps have the highest pressure working on them, and the lamps are too bright, while those groups which have the greatest number of lamps have the lower pressure and are too dim. Various attempts have been made to get over this trouble. I showed you in my previous Cantor lectures an arrangement which I myself had tried to elaborate, of an automatic switching of the lamps from one set of mains to the other, but I think it is too complicated, and not likely to succeed. Another plan occurred to me at the time, but the difficulties in the way of introducing it seemed so great that I did not mention it. This has been introduced in the Secteur Clichy, Paris. There is introduced at the different parts of the network what is called a compensator, which consists of four different dynamos all on the same shaft, and each dynamo is connected on one of the four groups. Suppose there is one circuit receiving too much pressure because there are too few lamps, then the pressure on the dynamo corresponding to that group is greater than the other four dynamos, and it will therefore act as a motor and be driven at greater speed than if it was quite out of the circuit. Being driven at greater speed, it raises the pressure in all the other different circuits, and thus in the circuits in the groups which have least pressure, the corresponding dynamos are acting as dynamos generating electricity, and in the groups where the lamps are fewest, they are acting as motors absorbing current and giving power to the dynamos. This is not satisfactory, the compensator requires to be continually at work, and the experience of the directors of the Secteur Clichy is that about 12 h.p. is being wasted in friction of the machine, and the consequence is it is a very wasteful system to introduce. Even though the machines are extremely perfect and require very little attention, still they need lubrication; the brushes need some attention; so combining the attention required and the waste there is in the friction of the machine, the system has not been approved, and is going to be abandoned. The alternative to which they have been driven is to use batteries of accumulators to act as compensators, put in at different parts of the network of mains—a series of batteries, say, 50 cells each, between each of the pairs of mains—that is to say, in parallel with each group of lamps. These batteries will maintain the pressure, and if there are too few lamps on one group, the current will pass through the battery and will be charging it up, and the battery will act as a regulator. They behave extremely well, but batteries are, of course, an expensive item. You will notice that this five-wire system—which would be more satisfactory and more economical—is very similar to Hopkinson's many wire system—an extension of his three-wire system, patented by Hopkinson and Edison simultaneously. The difference is that in Hopkinson's there is not a single dynamo of 400 volts, but four dynamos of 100 volts each, and they are put upon the separate groups. At the moment when the number of lamps on each group is the same, there will be no current passing through the intermediate wires, the four dynamos will be generating their 400 volts, and the current will be going in at one extreme wire and coming out at the other. When the lamps are used more on one group than another, then the intermediate wire will carry current, and one dynamo will be doing more work than another. I cannot conceive how they could have introduced in Paris an unnecessary difficulty by putting in one dynamo of 400 volts instead of four, which obviates very much the difficulties. Coming down to other high-pressure systems, the most important, and the one which has received the most development, is the alternate-current transforming system. The convenience of this is enormous. We are able to send an alternating current through an extremely fine wire to a great distance—a main one-twentieth part of the section will carry current supplying the same energy as in the low tension. Of course, it is dangerous to bring the high tension into our houses; but the transformer gives us the utmost facility, by the most beautiful contrivance, of transforming down and producing low pressure. By passing the current through one set of coils in the transformer, we do, by alternately magnetising and demagnetising the core, induce in the secondary coil—totally distinct from the primary—currents which are of low tension. This is of the utmost importance, because, in a properly constructed transformer, it is possible to ensure absolute immunity from danger, and from the high pressure entering the house. I regret that that is not always done in practice; inefficient transformers have been introduced, but there is no excuse for bad work in that way. The alternating current lends itself to distribution in another way, and this is a point which has not been sufficiently attended to in the past. The method which I have suggested is about to be adopted in the lighting of the City of London, and I think, when once it has been introduced there, it will be generally adopted in other cases.

You will remember, when I was speaking about feeders and low-pressure systems, I showed you that there was some difficulty in regulating the pressure in different feeders. There is not the slightest difficulty in this way with alternating currents. This can be done simply by the introduction of what is called a choking coil—coils of wire, in the centre of which we can introduce iron wire. By this means we are able to reduce the E.M.F. which is acting upon a feeder, without consuming energy, at the same time; and the distance to which we introduce the iron into the centre of the coil gives us the means by which we can regulate the E.M.F. on that feeder. We thus have the most perfect way of regulating the pressure in the different feeders. Another method is equally applicable, and that is to pass the current through a transformer in the central station, and take on the current from the whole of the secondary coil in the transformer, or rather less. We may switch on to different parts of the secondary coil, and thus, by adjustment, can take off current at 100 volts, and at different voltages. These two methods will in the future be of the utmost importance in electrical distribution by means of the alternating current.

The alternating current has been objected to on a great many different occasions by those who are either interested in supporting low tension for some reason, or who do not fully appreciate the merits and advantages of the alternating current. There have been certain disadvantages connected with it, which we must look to; and if we hope for the alternating current to survive as the best system, we shall wish to see these difficulties removed. The first important difficulty we need pay attention to is, that hitherto it has not been good for driving motors. This is not so serious a difficulty as it looks at first sight. The experience gained where motors have been put on lighting circuits has not always been favourable to that arrangement, and in many central stations it is found desirable to have separate machinery and separate distribution mains for the motor circuits. If the motors are not under the same conditions as the lights, and are doing at all heavy work, or are put suddenly on to a very large amount of work for a short time, such as lathes, etc., a strain is put on the electrical supply in the immediate neighbourhood, and the lamps in the vicinity become dim. In a motor circuit, the regulation of pressure to a very great nicety is not of such great importance, but in lighting circuits the regulation is of the utmost importance: therefore it is not desirable that they should be put on the same circuits. One of the chief reasons alleged for putting motors on the lighting circuit was that the load factor would be improved. This is not the case, however, as the two overlap at the busy time, the maximum amount of light being required at the same time that current is required for the motors. I believe that in the future developments of central station distribution by means of alternating current we shall have got over these difficulties entirely. The other difficulty which really needs to be overcome relates to electro-chemi-

cal operations. For these the alternate current is not very suitable. Of course, we cannot charge storage batteries, nor can we use the alternating current for electro-deposition. But current for electro-deposition is not generally let out from a central station, if it were a good plan to do so we might see a solution to the load factor problem by letting out current at cheap rates; as a matter of fact, for electro-deposition works it is cheaper to generate electricity direct than to take it from a supply company. As to storage batteries, it is very convenient to be able to charge storage batteries, but so long as our station is so managed that we do not require any reserve power, the necessity for storage batteries diminishes; and I must say, as the result of practical experience in the past, we are improving every year in the certainty of our supply of electricity, so that at the present moment there is really only an infinitesimal number of stations being called upon to supply electricity from storage batteries, and every year is diminishing the possibility of such a thing. I must say that such a supply is an advantage not to be overlooked in a well-regulated central station.

Now, I have said there will be some considerable changes in our methods of distribution of electricity by means of the alternating current. The greatest alteration which I expect will occur lies in the fact that it will be found most satisfactory from many points of view to introduce sub-stations. Up to the present it has been the custom, when using alternating currents, to put a transformer in the house of each consumer. It is in the first place somewhat costly to make separate transformers. In this, as in all other cases, if you make up a 1,000 h.p. in small units you require a very great deal more material and labour than when you make up the same in larger units. It is also inconvenient to put transformers in the houses for another reason—namely, that it is very much more difficult to regulate the pressure so as to keep it perfectly constant at all hours, because, in addition to the changes in the pressure owing to the distribution, as in the low-tension distribution, we have an actual loss in the transformer, and though a great part of this loss is a perfectly constant fall of pressure, and therefore does not affect the distribution problem, still there is a certain amount which is variable with the load; therefore we are introducing by this system an extra difficulty in regulating pressure. If we introduce sub-stations from whence the low tension is distributed, the pressure regulation can be done by attendants, provided always that we make them sufficiently large to make it worth while to employ attendants. There seems not the slightest doubt that we shall be able to adjust this in another manner, by making the transformers self regulating to a certain degree, so that it will be possible to place these large sub-station transformers in underground vaults, say, in places where they only require very occasional inspection, and where they do not require to have continual attendance. There are several inventions which have been made in this direction, and I had hoped to show you some which have been introduced by Mr. Ferranti, and he himself would have been most willing, but unfortunately, as you know, there are some troubles connected with foreign patents, and the possibility of too much being divulged prevents me from showing this apparatus. You can perfectly easily see that it is possible to arrange some sort of automatic switch, so that when the demand for current increases, an additional transformer will be switched into the circuit, and when the current falls off this switch will act in the opposite direction and put in a smaller transformer. It is also possible to wind our transformers, both primary and secondary, with more than one wire, and to have an automatic arrangement by which these coils shall be put in series or parallel, primary and secondary simultaneously, according to the different demands for current; that also will get over our difficulty. The effect of such changes will be to make the transformers work at their economical load. There is always a loss in a transformer due to hysteresis, and that loss is pretty constant whatever the demand for current may be. Now, by proportioning the size of our transformer to the load required, we are able to make the hysteresis loss a small proportion of the total current required to keep the transformer working at its efficient load.

At the present time, with a transformer in every house, transformers are working in a very inefficient manner during the greater part of the time, both when the load is light and during the daytime, when no secondary current is being taken at all. These transformers must always be supplied with current, and even during the daytime consume an appreciable amount of energy—that used in overcoming the hysteresis of all the transformers over the whole town. But with our sub-stations supplying secondary low tension to the mains, we shall have only a very small number of transformers at work during the hours of light load, and the consequence will be that each transformer will be working in an efficient manner during the whole 24 hours. I think we may safely look for an average efficiency of 90 per cent. during the whole of the 24 hours. I may say the feeling at the present time is very general among engineers that sub-stations ought to be introduced, instead of having transformers in every house.

If we are to introduce these sub-stations, it becomes necessary to review the whole system of distribution, and consider whether we are working in the right direction. There is one point requiring radical modification—i.e., the frequency of alternations used in connection with our distribution. When the pioneers in this line started work it was of course looked upon as a great feat to get nearly the whole of the energy transformed and supplied in the secondary circuit, and it was a great feat to do this by means of cheap apparatus. It was impossible to do this cheaply and economically unless we used very small transformers; and the only way in which we could use very small transformers, with high pressures of 1,000 volts, was by having rapid alternations, and, consequently, the pioneers used dynamos which gave very rapid alternations and a very small transformer. The result is that you get a very considerable consumption of energy due to the hysteresis of this transformer.

Now, when we come to use sub-stations with very large machinery, the economy which is to be gained by using high frequency is not nearly so large, not nearly so well worth considering, as it is when we are dealing with scattered lighting, and able to put transformers more economically in every house. For this reason, then, I think it would be desirable to reduce the frequency of our alternations as low as the frequency of the alternations in an ordinary continuous current dynamo armature. That is to say, reduce from 130 and 80 periods per second down to something like five or 10 periods per second. There are other reasons why we should use low frequencies. When we have secondary mains of that large section of copper used in our low pressure systems, it is only with difficulty that we can force a current of high frequency through it.

High frequency has a remarkable effect on the conducting qualities of large conductors. The whole of the current is forced towards the outside of the conductor, and makes the inside of the conductor almost useless as a means of carrying the current. It is only by diminishing the frequency of our alternations that we shall be able to get over this very serious trouble, which will attack us as soon as we have low tension mains carrying alternate currents. There is another advantage in using low frequency currents, and that is, the problem of electromotors is immediately solved.

It has been a wonder to many why we could not use continuous current motors with the alternating current, if the field magnets were made of laminated iron. It was said that a current in the one direction drives the motor in the one way, and if we reverse the direction of the current, it still goes on in the same way. Why should not this happen with an alternating current? So it would, but the employment of an alternating current to magnetise the field magnets of these motors involves an enormous counter E.M.F. set up in the coils round the field magnets, as the effect of what is known as self induction; the consequence is that a great proportion of the volts which we supply to the motor is taken up in magnetising the field magnets. I have calculated out the particular case of a 10 h.p. motor working at 100 volts, and I find that though the field magnets be laminated in the best possible way, this motor, when worked by an alternating current, would

require 99 volts in addition to the 100 volts actually needed when worked with a continuous current—practically 100 extra for exciting the field magnets. When that motor is used with a continuous current, only ¾ volt is required for magnetising the field magnets, so that you would have to work at 200 volts to supply the motor with an effective E M F of 100 volts, and yet at the present moment motors of that character are being used largely in America on lighting circuits, for some purposes where the power used is small, so that an output of 30 or 40 per cent. of what might otherwise be obtained is ample for the purpose. I have calculated that if you were to reduce the frequency to five periods per second, the volts required in that case for exciting the field magnets would be six instead of ¾ volt.

We should thus be diminishing the output of the motor down to 90 per cent., which is not a serious thing, and be making the use of such a kind of motor practicable. We know perfectly well that alternating current motors are being developed by other means, and that some of them are far superior in practical working to any of the continuous current motors; and, consequently, the direction in which this part of the subject will be extended is almost certainly in the development of these new types of motors, which have attracted so much attention elsewhere. Even for that class of motor, too, there is no advantage in having high frequency, and it will be a distinct gain to have low frequency. Low frequency will also enable us to introduce a commutator in such a way as to convert alternating current into continuous, and that will enable us to charge storage batteries. At the present time the only way of doing this with alternating current is to employ an alternating-current motor and cause it to drive a continuous-current dynamo machine. By that means we are able to charge storage batteries; but by introducing low frequency the advantages are so great that I think it is most desirable, when we are considering the question of using sub-stations with large transformers supplying the secondary mains, that we should also consider the other alternative of using low frequency, and a commutator to convert the alternating into a continuous current. The only reason why we use high frequency is the large number of transformers; it economises their construction, and we are able to have a cheaper transformer, but you will see that that *desideratum* is diminished when we come to the sub-station method of distribution.

Other systems of establishing high tension have been proposed, the most important that has received attention being the continuous-current transforming system, which consists in sending high tension continuous current from a central station to a distant sub-station, where the current is received and passed through a motor, which serves then to drive a continuous-current dynamo of low pressure. That dynamo then serves as a source of energy to the neighbourhood around, supplying the mains in its immediate neighbourhood. We can have several of these sub-stations, so that from one central station we are able to distribute our power in the form of high pressure electricity to several distant points, and then to produce low-pressure electricity and distribute through our mains. These combination machines, of motor and dynamo combined, can be made of a very high degree of efficiency owing to a remarkable fact. The efficiency of a dynamo or motor is impaired by the reactions produced by the currents in the armature, and these reactions, in the case of dynamo and motor, are in opposite directions. If now we wind a high tension winding on an armature to serve as that of a motor, and on the same armature we wind a low tension winding which is to act as that of the generator for the low-pressure supply, and put a separate commutator and a separate pair of brushes to each of these windings, we have the same machine acting as a motor and as a dynamo, and we have an absence of those armature reactions which would be produced either by the motor winding or by the dynamo winding alone, because they are produced in opposite directions by the two windings when we use one as a motor and the other as a dynamo, consequently we have an apparatus which is extremely efficient and useful.

(*To be continued.*)

ELECTRIC LIGHT AND POWER.

BY ARTHUR F GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

II.—MOTIVE POWER.

Sources of Power.

(*a*) *Artificial.*—People look considerably surprised when they are informed that the production of electricity, and hence the electric light, is attendant with the consumption of a good deal of power; that, for example, a steam engine yielding six brake horse-power will only run 60 incandescent lamps of 16 c.p. at the utmost. They all know that there is such a thing as a "battery," or a "cell," and have a dim recollection that zinc or some other metal is put into a jar containing some acid, or chemical solution, and that from this simple apparatus you can obtain an electric light—as you can in a fashion—so when they learn that a boiler and steam engine is required to run 50 or so glow lamps, or half-a-dozen arc lamps, they cannot understand the reason. It is interesting to draw a comparison between the power generated by a battery and by a dynamo. For every pound of coal burnt per hour under the boiler, ¼ b.h.p. can be produced, and this would run three glow lamps of 16 c.p. each; if a battery were employed to supply the same amount of electrical energy for the same time, it would be found that ½lb. of zinc would have to be burnt. The cost of the coal may be put down at less than $\frac{1}{10}$th of a penny, whereas the cost of the zinc is twopence, or the fuel for a battery is 20 times more expensive than the fuel for a boiler and steam engine. This is why batteries are entirely out of the question for generating large quantities of electrical energy, and even if the cost of the battery fuel was much less, it is doubtful whether they could be of much practical use on a large scale. The chief way to obtain power is by burning some material either in a solid, liquid, or gaseous state. As a solid, coal is burnt under a boiler, and the heat so obtained utilised in converting water into steam, at a greater or less pressure. As a liquid, petroleum or other oils can be cited, which are used the same way as the solid fuel. As a gas, coal gas is compressed and exploded, the explosion yielding energy, arising from the expansive force of the gas. Hence, the steam engine, oil engine, and gas engine, using respectively a solid, a liquid, and a gaseous fuel, belong to the class of artificial sources of power, and bear witness to the ingenuity of man.

(*b*) *Natural.*—Besides these, there are the great natural sources of power which engineers are continually directing and subjecting to their use—a mountain torrent, a swift river, a waterfall, wherever a body of water is moving from a higher to a lower level—all will yield a continuous supply of energy, in great or small quantities, according to the rapidity and volume of water rushing down. Then there is the ebb and flow of the tide, which is the greatest source of wasted energy on the globe. Twice daily do the billows surge and thunder on the shore, and it is only when one gazes, fascinated at the wide glittering expanse of seething waters, as they hurl themselves on a rock-bound coast, that any slight idea can be formed of the terrific forces at work, millions of horse-power being wasted every mile of coast they encircle. So truly the foam flakes, the expressive token of all this energy, possess as much value as if they were solid flakes of silver, could but this immense display of power be utilised! Attempts have already been made to store the force of the tidal motions, and, at the present rate of invention, we shall undoubtedly in the near future arrive at the ways and means of doing so. Another natural source of power is the wind, from the gentle breeze to the fierce tornado. This power has been used for driving ships for ages, and although steam has supplanted most sailing ships, still a good number remain. On land the many windmills on elevated ground scattered all over the country indicate how its power is utilised, although its services are very fitful and erratic.

Conservation of Energy.

All energy on the face of the earth has its origin in the sun. Coal is the product of the sun's rays acting for countless ages on vegetable matter, and the undergrowth of primeval forests, the heat of the sun thus being stored. By digging out the coal and burning it, we regain the heat which was dissipated ages ago. In the dense and boundless

forests of Central Africa and other unexplored parts of the world, the sun is probably storing up for us untold wealth, ready for the future use of the denizens that will some day inhabit the land. It is the same with water power; it is the energy of the sun's rays which evaporates the water in our seas and lakes, and this water vapour, ascending into the sky, is wafted by the winds hither and thither until, coming into a strata of cool temperature, the vapour condenses into a rain cloud, and thus returns to the earth's surface in the form of rain. When the rain falls on elevated regions, such as mountain summits, a mountain torrent is produced, which as it dodges and dashes down to the plains below mingles with other torrents, and so the body of water accumulates until it meanders over the plains on its way to the sea, a broad, shining river; and so the cycle of changes go on, the water taken up into the clouds from the sea being caused to return again. Again, it is the sun's rays which produce winds: the heated air rises upwards, and immediately a rush of cold air takes place to fill the space vacated.

From the above general remarks it will be seen that really there is no waste of energy. The word "waste" is only used to express that which we cannot utilise for our own purposes, hence there is only a transformation of energy going on from one form to another form. This great fundamental law of nature is termed the "conservation of energy," and it must be implicitly accepted, and thoroughly recognised and understood when dealing with "electric power," just as it should be when dealing with any other subject which treats of energy. To make this statement more emphatic, let us follow the several steps of transformation of energy that take place in reproducing the light of the sun in the form of an electric lamp. First, the heat is stored as coal, which has been very aptly termed by Mr. Preece "preserved sunbeams"; coal being burnt, evaporates water into steam, steam drives the steam engine, and thus this third transformation consists of changing the energy of heat into mechanical power. By causing the steam engine to drive a dynamo, a fourth change occurs, the mechanical power being now converted into electrical power. The final transformation occurs when the electric current in passing through the lamp filament generates such intense heat that it produces light. Hence there are five transformations of energy between the light of the sun and that of the electric lamp. It may be asked, Why is it necessary to have so many changes, for each change signifies a loss, according to the commercial efficiency of the machines or converters employed? and, Why cannot we obtain electricity direct from coal, without these intervening converters? The answer is that our present state of knowledge will not permit us. The problem has been attacked, but so far, without the slightest practical value arising. Five different transformations is a good number, and a roundabout way certainly, but as we see no other way, we must put up with it.

The following remarks give an idea of the losses that occur in each converter, at the present state of efficiency:

Of the total heat energy contained in burning coal, only 50 per cent. can be said to be utilised to evaporate water into steam, hence the boiler has an efficiency of only 50 per cent.

Passing on to the steam engine, it may be said that the very best steam engines built only utilise from 9 to 10 per cent. of the heat energy evolved by the burning coal, and since the efficiency of a boiler is 50 per cent., this makes the efficiency of the engine 18 to 20 per cent., allowing the low figure of 2lb. of coal per brake horse-power—a performance very rarely met with. On allowing 4lb. of Welsh coal per brake horse-power, the efficiency of the engine is brought down to 9 or 10 per cent.—that is to say, that only 10 per cent. of the heat energy of the steam admitted into the cylinders is converted into available power, and when calculated from the heat energy of the coal burnt under the boiler, the amount utilised becomes 5 per cent. However much boilers and steam engines may be improved it cannot, by any possible way, prevent this source of power from being terribly wasteful. On theoretical grounds, the employment of fuel in the form of a gas (such as coal gas) and oils (as petroleum) to drive internal-combustion engines, known as gas engines and oil engines, gives a much higher efficiency than the best-made steam engines and, sometimes twice the efficiency; but since this form of fuel is more expensive than coal, steam power is most economical for large power.

We have now reached the third converter—the dynamo, the machine that transforms the mechanical power given by the driving wheel or driving shaft of the engine into electrical power. Concerning the marvellous state of efficiency to which a modern dynamo has now been brought, it is difficult to find a parallel example. No less than 96 per cent. efficiency has been obtained in these machines for transforming mechanical energy into electrical, and every dynamo on the market can point to 87 per cent., and, in addition to this, the small percentage of loss can be entirely accounted for and measured, thus proving to the hilt the law of the conservation of energy. The fifth and last transformation takes place in the electric lamps, where the electrical current spends its power in heating up the carbon filament of the lamp to an incandescent state, and producing light. The energy that caused the sun to shed out light and heat thus, through numerous changes, reappearing in the light and heat of a miniature sun or electric lamp.

The commercial efficiencies of the several converters are tabulated below, taking 4lb. of coal for 1 b.h.p.

—	Heat units.	B. H. P.	e	E
			%	%
4lb. of coal burnt per hour produce...	58,000	22·4	100	100
Amount of heat utilised by boiler......	29,000	11·2	50	50
" " " " engine ...	2,842	1·0	9·8	4·9
" power " " dynamo..	2,643	·93	93	4·55
" " " " lamps ...	2,590	·91	98	4·45

e denotes the commercial efficiency of each converter—that is, the amount of work done by the machine, as compared to the power put into the machine. E denotes the "commercial efficiency" of each converter as compared with initial power supplied by the coal.

The last transformation—*i.e.*, converting the electricity into light—is given as with a loss of 2 per cent. This loss is entirely dependent on the distributing wires, and so can be made anything; but 2 per cent. for short distances, say a radius of 100 yards, is sufficient; in fact, is very high. By running the electric lamps close by the dynamo no loss, practically, is incurred, because there is no length of wire between the two. There is thus a total commercial efficiency of only 4·45 per cent. between the heat energy of the coal and the heat energy as it appears in the electric lamps. This is when steam power is used. No wonder that people strive to obtain electric power direct from burning coal, without the intervention of the wasteful steam engine.

(To be continued.)

WAVE PROPAGATION IN MAGNETIC MATERIALS.*

BY PROF. FITZGERALD.

Taking the particles as a set of magnets held in place by one another's mutual attractions, and assuming as a first approximation that the moment on any needle is proportional to the sum of its own and its immediate neighbour's rotations, then the velocity of proportion of a wave is given by

$$v = 2\, N_0\, \lambda \cos \frac{\pi l}{\lambda};$$

where N_0 is the frequency of vibration of each magnet when its neighbours are fixed, λ is the length of wave generated, and l is the distance between the centres of neighbouring magnets, and to determine the frequency corresponding to a given wave-length, we have

$$N = 2\, N_0 \cos \frac{\pi l}{\lambda}.$$

From this we see that N cannot be greater than $2\,N_0$, and that in that case $\lambda = \infty$, while that for smaller values of N we have the wave-length decreasing until $N_0 = 0$, when $\lambda = 2\,l$, which is the minimum wave-length. This last is obvious, because when the magnets are swung very slowly from side to side, each takes the phase opposite to its neighbour and consequently $\lambda = 2\,l$.

Thus it appears that the wave-length will be very small unless N is comparable with N_0.

* Paper read before the British Association at Edinburgh.

In order to calculate N_0, we may estimate roughly the quantities involved. If we take each magnetic particle to have $l = 10^{-7}$; and if we assume such strengths of poles that the lines of force per square centimetre from them would be 1,000, we can estimate for a material whose density is 7 the moment of inertia of its elements, and the moment of each as a magnet, and thus I have very roughly estimated the time of vibration of each element, and find $N_0 = 1{\cdot}6 \times 10^{-8}$. If the elements are estimated as smaller, this frequency will be much increased, proportionally to the second power of the dimensions, so that if the size of the molecules were 10^{-8}, the frequency would be about 10^{10}. If, however, the strength of the poles decrease, there will be a corresponding decrease in the frequency, so that we must not take the calculation as anything but very rough indeed. It would appear, however, that frequencies comparable to those of Leyden jar discharges might produce waves of measurable wave-length, and that waves of a frequency comparable to that of light would probably not be propagated at all.

This agrees with Prof. Dewar's recent observations that light is sensibly completely polarised by liquid oxygen, a transparent magnetic medium, and with the fact that a strongly magnetic medium like iron seems not to have any very obviously peculiar properties in respect of the reflection of light, except those very minute, and consequently, in all probability, secondary phenomena, due to its being magnetised, and which Mr. Kerr so wonderfully discovered.

It would also account for the fact that Leyden jar discharges are not too rapid to create absorption of energy by iron, and might lead us to expect that possibly liquid oxygen itself may have a corresponding powerful absorbing power for some very long waves, although it is so good a non-conductor.

It also accounts for the want of success that has attended attempts to measure, by interference, the rate of propagation of waves of low frequencies in iron, for the length of such waves becomes comparable with the inter-molecular distances, and so out of reach of the means of observation used, the velocity of propagation being very low.

These considerations would also lead one to expect that the elementary magnets could easily follow much more rapid magnetisations than occur in transformers, without any sensible change in the nature of the law of magnetisation. This naturally leads to the question as to how far the magnetic motions may be damped, because it may very well be that there is no free period of vibration, and in that case this investigation would fail. A comparatively slight damping of motion would stop such rapidly vibrating elements.

This investigation only deals with small magnetising forces; the large one usually dealt with in transformers are propagated much more like an explosion than like a wave.

COMPANIES' MEETINGS.

DIRECT SPANISH TELEGRAPH COMPANY.

The thirty-eighth ordinary general meeting of this Company was held on Tuesday at Winchester House, Old Broad-street. The report of the Directors stated that the accounts for the half-year ended June 30, 1892, showed, after providing for debenture interest, a balance to the credit of profit and loss of £5,438. The traffic receipts showed a decrease of £45, as compared with those of the corresponding period of 1891. They might, however, be considered satisfactory, as in the half-year of 1891, with which they were compared, the present reduced tariff had not come into force. The working expenses were £170 in excess of those for the corresponding period of last year. The Company's cables and the land lines in connection with them had continued in good working order throughout the half-year. After putting the usual sum of £2,500 to the reserve fund, the balance of profit and loss amounted to £2,938. Out of this amount the Directors recommended the payment of a dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend at the rate of 4 per cent. per annum, free of income tax, on the ordinary shares. There would then remain a balance of £441, which would be transferred to the reserve fund in part repayment of the sum of £2,736 taken from that fund towards the repairs of the Falmouth-Bilbao cable in November, 1891. The reserve fund would then amount to £29,827.

The Chairman, in moving the adoption of the report, said at their meeting in March he called attention to the reduction of the tariff by one halfpenny per word, and said if the traffic did not increase it would mean a loss of £1,700. But the growth of the Spanish traffic, resulting from the commercial treaty with Spain, had continued, and they had telegraphed 43,000 more words than in the corresponding half of last year. From 1886 there had been a continuous growth each year, so that they did not take a despairing view of the loss of a halfpenny per word which the conference had inflicted on them. This half-year there had been an increase of 10,000 telegrams, or 130,000 words; but he was obliged to say that this was not the result of a normal growth, as the merchants used their lines very freely, with the object of getting their goods into Spain before the old treaty expired. Business seemed to force merchants more and more into telegraphy, and he hoped that this would prove the case, for it was the mainstay of their revenue. In his opinion telegraphy did best when the business pendulum swung both ways with a profitable result. Since the treaty expired on the 30th of June, the growth of their traffic showed an increase. The reduction in the length of messages by codifying had ceased, and they were now one word per message better than they were a few years ago, when there seemed to be no end to the ingenuity of code-makers. He would leave the future to itself but three minutes to Bilbao and 20 minutes to Madrid for a message, came as near dealing with one's foreign correspondent in the same room as could be desidered. They were looking forward to the renewal of their 6 per cent. debentures in 1894 at a lower rate, but that would depend on the state of their revenue. Much would depend on their freedom from breaks and extensive repairs; but the Directors' policy would be to maintain their shares as a good investment with as little fluctuation as one saw among the better securities in the lists of the London Stock Exchange. They were making a very fair revenue, and must be satisfied with it. He had no idea what might happen at the next conference, which he was glad to think was still three years hence, for the ideas of the Post Office and of European Powers might be modified in the meantime. At present they were talking, and he hoped that it was only talk, of a uniform continental tariff; but a good many Governments were losing by their telegraphs. The Australian colonies wanted to raise the tariffs, and he hardly expected that there would be any great *furore* to lower them. The tariffs could not be reduced without loss of money, and 4 per cent. was not too much—in fact, not enough—to pay for this class of enterprise.

Mr. Edmund Ettlinger seconded the adoption of the report, which was agreed to, and the meeting concluded with a vote of thanks to the Chairman.

LEGAL INTELLIGENCE.

IN RE HOBBS AND CO.

In the High Court of Justice, Chancery Division, before Mr. Justice Barnes, on Wednesday,

Mr. Marten, Q.C. (with him Mr. Herbert Burne) applied on behalf of creditors that the firm of Hobbs and Co., builders, should be wound up.

Mr. John Chester applied on behalf of the American Elevator Company, who had also lodged a petition for the carriage of the order. He said that his clients' claim was for £32,000, which was secured by mortgages. The firm were the builders of Whitehall-court and of the large flats recently built near the French Embassy, and called Hyde Park-court.

Mr. Ford supported the petition on behalf of the Kensington Electric Lighting Company, who had arranged to light the buildings.

Mr. Brodie Cooper and Mr. Eldridge also appeared.

A winding-up order was made.

BUSINESS NOTES.

Warminster.—The new fountain at Warminster is to be lighted by electric light by Mr. Mark Hill, at £15 a year.

Globe Telegraph and Trust.—An interim dividend of 1s. 9d. per share has been declared by the Board, payable on the 18th prox.

Notice of Removal.—The registered offices of the General Electric Power and Traction Company are now at Worcester House, Walbrook, E.C.

Windermere.—The application by Mr. Fowkes for leave to lay an underground cable for electric light in Windermere was deferred for guarantee that the work should be permanent.

Westminster Electric Supply Corporation, Limited.—The offices of this Company have been removed to the central station at Eccleston-place, Eccleston-street, Belgravia, S.W.

Ullswater.—The General Electric Power and Traction Company have completed installations by which the Greenside Silver Lead Mines at the head of Ullswater will be lighted by electricity.

Dolgelley.—At the meeting of the Dolgelley Local Board, the clerk reported that the Lighting Committee had come to terms with Mr. Hall, of Liverpool, to light the town with electricity.

Western and Brazilian Telegraph Company.—The receipts of this Company for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,584.

West India and Panama Telegraph Company.—The receipts for the half-month ended September 15 were £2,146, against £1,844. The May receipts estimated at £5,895, realised £5,901.

Otterbourne.—Tenders for the lighting of the Southampton Water Works at Otterbourne must be sent in by the 27th inst. Mr. J. G. Waldridge, of 9, Victoria-street, is the electrical engineer.

New Telephone Company.—The offices of the New Telephone Company, Limited, will be removed on the 29th inst. from 110, Cannon-street, to the Telephone Exchange, 58 and 59, London-wall, E.C.

Chertsey.—The Board of Trade have written to the Chertsey Sanitary Authority agreeing to an extension of time as requested by the Weybridge Electric Lighting Company, in order to arrange for a continuance of the supply of current to Chertsey.

Greenock.—On the rebuilding of the Orchard sugar refinery at Greenock, recently destroyed by fire, it has been resolved to introduce the electric light. The work of installation has been entrusted to Messrs. Norman and Co., Limited, of Glasgow.

Fleetwood.—The Fleetwood Commissioners have decided not to entertain the offer of the gas company to purchase the works for the town. They think electricity better worth their attention, and four estimates for lighting the town by electric light have been obtained.

Oxford.—The Oxford City Council have authorised the annual expenditure of £210 for three years, in addition to the present cost of lighting, for the purpose of introducing the electric light for street lighting. Eighteen arc lamps will be erected, to displace 56 gas lamps.

City and South London Railway Company.—The receipts for the week ending September 18 were £744, against £684 for the same period last year, or an increase of £60. The total receipts for 1892 show an increase of £785 over those for the corresponding period of 1891.

Wrexham.—The estimate from Mr. Sillery, electrical engineer, Chester-street, Wrexham, offering to connect the Guildhall with the water works offices, and with the Regent-street office of the town clerk by telephone for £25. 10s., including supervision for two years, has been accepted.

Eastern Extension, Australasia and China Telegraph Company.—The Directors have declared an interim dividend for the quarter ended June 30 of 2s. 6d. per share, free of income tax, payable on October 15 prox. The share register will be closed from October 7 to October 14, both days inclusive.

Shiplighting.—The "Iona," built by Messrs. Gourlay Bros. and Co., of Dundee, for Messrs. W. Thomson and Son, is designed for the Canadian cattle trade, and fitted with the latest improvements for the safety of the animals. Special attention is paid to lighting, and the ship is lighted throughout with electric light.

Rockhampton Gas and Coke Company.—Messrs. Wm. Coward and Co., of 11, Queen Victoria-street, E.C., notify that they have received from the Rockhampton Gas and Coke Company, Queensland, the dividend for the six months to 30th June, 1892, due to the English shareholders, at the rate of 10 per cent. per annum.

Dundee Tramways.—A meeting is to be held at Dundee to discuss whether the tramways are to be taken over by the Corporation and worked for the benefit of the community. Dundee is shortly to have electric supply, and the probable change of ownership of the tram lines may lead to the introduction of electric traction.

Colombo.—The Government has decided to have the electric light supplied at Colombo to the post office, the Queen's House, and the wharf, while the hotel proprietors have sanctioned the use of electric light. Messrs. Siemens Bros. are taking up the matter. The lighting of the streets is not likely to be carried out at present.

Coatbridge.—Messrs. J. E. H. Gordon and Co., Limited, of 11, Pall-mall, have obtained a contract for the electric lighting of Coatbridge, and are proceeding to erect a station of 3,000 lights capacity with all the necessary street mains. The machinery is in hand, and it is expected that the work will be finished in the early spring.

Siemens and Halske.—Tales are rife of enormous endeavours made by the combined Edison-Thomson-Houston Trust, in America, to buy all the impending Siemens and Halske Company, of America, repaying the quarter of a million already spent, and goodness knows how much more as a bonus. But without avail—competition will still be there, and stronger than ever.

Pulsometers.—The Pulsometer Company have now adopted what they termed the "Grel" arrangement to their pulsometers, by the use of which the steam is automatically cut off before the end of the stroke, allowing the steam to act expansively, to the saving of some 40 per cent. of the steam. These peculiar pumps are always useful in engineering works, and will now be even more advantageous.

Burnley.—The Corporation of Burnley invite tenders for the supply and erection of machinery for their central electric station, and for cables in the streets, as a whole or in parts brought livestone, as follows: boilers, fuel economisers, engines, travelling cranes, dynamos, accumulators, switchboards, cables. Specifications, forms of tender, and other information may be obtained from Mr. J. P. Leather, Gas Works, Burnley, and the tenders are to be sent in by October 26th.

Bradford Tramways.—The Bradford Tramways Committee report that the engineers of the committee lead them to believe that electric traction, like the cable system, would be too costly for them to adopt, and that steam traction would be the best system. It is a pity some electrical firm could not convince them of the advantages of electric traction, for a entirely opposite view has been taken in America, where whole sets of steam and cable cars are laid aside for electric cars.

Wigan.—At Wigan Town Council a letter was read from Mr. Alfred Peck, the managing director of one of the largest local undertakings, saying he would like to take the electric light, but not at 6d. a unit, which was nearly double the price of gas. Mr. C. B. Holmes, chairman of the Gas Committee, pointed out that 6d. was considerably less than was charged at most other towns, and that he thought supply even at 6d. would entail a loss during the first year, and a reduction could not be conceded till this loss had been made up.

Windsor.—A contract has been signed between Messrs. J. E. H. Gordon and Co., Limited, of 11, Pall-mall, and the Windsor and Eton Electric Company, for the erection of an electric light station at Windsor, and for the running of mains along the High-street and a portion of Peascod-street. The work has already been put in hand, and it is expected that the light will be supplied before Christmas next. The installation is only a small pioneer work, but arrangements are made for a large extension as soon as the success of the first instalment has been demonstrated.

Bolton.—A movement is on foot for the extension of electricity in Bolton, and six tenders for electric installations have been submitted to the Gas Committee and referred to the mayor (Alderman Nicholson), the chairman (Alderman Miles), the vice-chairman (Alderman Broughton), and Councillor W. Cooper, and report thereon to the committee at an early date. We understand, says the *Bolton Journal*, that it is intended to fix the installations in shops in the vicinity of Town Hall-square and streets leading thereto, and if successful to extend electricity throughout the borough.

Leicester.—It is expected that the electric light question will be now made a prominent one in local politics at Leicester. For two years it has been in abeyance, and the time of consideration granted to the committee will elapse in a couple of months. Tenders have been invited, and the sub-committee have opened and considered these, for laying the mains in the centre of the town. In all probability, the committee will recommend the Council to carry out the terms of the provisional order for supplying light in the town, but nothing definite will be done before November.

Sutton Coldfield.—A set of "Victor" turbines has been supplied by Mr. F. Nell for the Sutton Coldfield Corporation at Blackroot Pool, Sutton Park. The turbines are housed in a handsome wood chalet, and drive a stone breaker and saw bench. Alderman Evans said he thought the use of the machinery should not be limited to these uses, but that sooner or later they should be able to test its illuminating power—he meant that they would be able to light the Town Hall by electricity. He was sorry their finances would not allow them at present to adopt this system, but the time would come when they could carry out this project.

Belfast.—At the bi-monthly meeting of the Belfast Harbour Board on Tuesday, the question of lighting the harbour by electricity was discussed. Mr. Greenhill suggested it. Mr. Wolff also spoke strongly in favour of some steps being taken in this direction, saying it was almost a disgrace to Belfast that she alone almost among the important ports of the United Kingdom and of Europe was not supplied with the light. The matter has been referred to the Works and Traffic Committee for enquiry and report. We trust that some of our enterprising firms will take care that the matter does not lapse, and that the Harbour Board will be furnished with all the information required.

Temporary Lighting.—A very successful temporary installation of the electric light was carried out by Messrs. Rawlings Bros., of 82, Gloucester-road, on Thursday last week, the occasion being a garden party given by W. Burdett-Coutts, Esq., M.P., at Holly Lodge, Highgate. The lighting was effected by incandescent lamps run off Epstein accumulators, type X., three cells, consisting only of one positive and two negative electrodes, and which, owing to the small space they take up, their large storage capacity and almost unlimited range of discharge, are admirably adapted for such purposes. Messrs. Rawlings Bros. were much complimented by host and guests on the brilliancy and steadiness of the light and the efficacy of the switching arrangements.

Heckmondwike.—The answer from Mr. Hutchinson, C.E., about the £10 cheque for consulting services was read at the last meeting of the Heckmondwike Board. It stated that the £10 was to be paid if the plans were not accepted, but only be taken as part payment if the plans were carried out. It referred to the work and visits done in preparing specifications, with reference to the professional reputation of the writer, and concluded by offering to free the Board from liability if the documents were returned. The letter was referred to the General Works Committee. An offer from an electric lighting company to light the town for a period of six or ten years was held over. On Monday the Board adopted by an overwhelming majority the resolution authorising the construction of the needful plant for a central station and the application to the Local Government Board for sanction to borrow the necessary money—about £6,000.

Swindon.—The committee appointed to consider the purchase of the gas works cannot recommend this course. Mr. Morris pro

posed the committee should be empowered to ascertain the cost of electric light. Mr. Hinton thought Swindon a town peculiarly fitted for electric light. The clerk produced a tabulated list of the cost of lighting by electricity in other towns. Questions had been submitted to other authorities, "Do you find electric lighting cheaper than gas?" Most of the replies were that it was dearer, and in one instance double the cost, but the superior light far outdistanced the cost. In one instance it was cheaper, but there it was worked by water power. The chairman and deputy clerk suggested that the whole matter should be referred back to the committee for further consideration, and in the meantime they might ascertain the probable cost of lighting the town by electricity. This was agreed to, a majority of the members voting for Mr. Morris's proposition.

Train Lighting.—The Midland and the other great railways with lines running out of London are prepared, we are told, to follow the example of the Metropolitan and provide electric lamps for the use of their passengers. It is not intended at present to displace the gas, and this can be done by making the passengers desirous of a better light pay for it themselves by a penny in the slot arrangement. But it is not unlikely that the gas may be displaced eventually. The lamps which are being prepared for use on the main lines will be installed at the outset only in trains running long journeys. The batteries will be charged with a supply of electricity sufficient to provide a continuous light during two days, so that they will not require recharging until the trains return to London. This departure is a significant one for the makers of secondary batteries, for it shows that the smaller sizes of cells are likely to be used in very large quantities. Small cells seem likely to prove one of the most important branches of the storage battery trade, and the railway companies one of the principal customers.

Bradford.—The half yearly financial statement of the Bradford Electricity Department was presented by Alderman Priestman at the meeting of the Town Council last week. The accounts were for the half-year ending June 30 last. The total expenses on revenue account during the six months were £1,573 and the total revenue £3,216, leaving a trade profit of £1,642. The interest paid on loans out of this sum amounted to £678; and the contributions to the sinking fund were £577, leaving a net profit of £387. At the end of the present year the Corporation would have contributed £3,027 to the sinking fund since the construction of the works. Up to the present time the actual amount contributed to that fund was £2,449. The total liabilities at present in respect of loans were £42,542; and the floating liabilities amounted to £47,896. There were also £400 excess of assets repaid through the sinking fund, and £2,750 was in the bank on sinking fund account. Up to the present time there had been a total loss since the commencement of the works of £799. There had been expended on capital account during the half-year £5,130, and under the heading of floating assets, there appeared in the accounts a sum of £1,029 in respect of sundry debtors and £165 in respect of sundry materials, bringing up the total amount of floating assets to £1,194. The total assets on the capital account were £49,615. Since the commencement of the works there had been paid in interest and on sinking fund account £5,625. The trade profit which had been made amounted to £4,825. There was a loss of £1,079 on the first half year's working; in the second half-year, £732; in the third, £315; and in the half year ended June, 1891, £30, the total being £2,157 6s. 8½d. At the end of December last there was a net profit of £970; and at the end of June of the present year it was £387. If the total net profit were deducted from the total net loss it would show a net loss of £799 still to be made up. He thought a considerable portion of this sum would be made up before February or March, when the next half year's accounts were presented. The accounts were adopted.

Electric Power in Tasmania.—A number of shareholders of the Australasian Rights Purchase Association, Limited, met recently to inspect the water motive power for generating electricity to supply light and power to the mines at Mount Zeehan and Dundas, Tasmania. The plant is as follows: It comprises 262ft. of piping with an intake of 7ft. 3in. in diameter, gradually reduced to 15in., off which two nozzles are taken of a 4in. diameter each, to play upon a Pelton wheel which has a diameter of 5ft. The test pressure of the pipes being 178lb. to the square inch, and a working pressure will be 100lb. to the square inch, thereby giving a result of 900 h.p. to generate electricity. From this station electricity will be transferred by a wire on poles to mines within a radius of 10 miles, which power will be available for the purposes of lighting, haulage, boring and pumping. The scheme originated from the extreme cost of mining in new districts owing to the want of roads suitable for the cartage of machinery. The only means of avoiding such heavy expenses was by the application of electricity. Having taken up the water rights and obtained a Bill through the Tasmanian Parliament, contracts were entered into with Mr. Wadey to supply the whole of the water power plant. The electrical portion of the scheme is now being taken in hand, and it is anticipated that it will be completed by the time the water power portion was in position. Mr. Musgrove, of the London Electrical Storage Company, said he was pleased to be present to have an opportunity of assisting to place before the Australian public the great advantages and manifold purposes that electricity could and would be applied to in the near future and trusted that his remarks regarding the present venture would be received in the spirit intended—viz., the universal benefit of all. Firstly, he trusted that the Australasian Rights Purchase Association would exercise great care in adopting electrical appliances, that as progress was made in electrical science such initial works would be capable of embracing all new ideas without having to reconstruct or reorganise the whole plant to meet such requirements. He instanced the necessity of plant that would be suitable for supplying lighting power for stamps, boring, blasting, depositing of metals by electricity, which would in the near future play a most important part in the mining world. The mine owners of Zeehan and Dundas are prepared to take the power provided the Company would give practical demonstration that it was cheaper than other motive power. Mr. Marks described a visit which he paid to Skipper's Creek, New Zealand, where a similar electrical scheme had been carried out by the Brush Electrical Engineering Company. We can add to this information that Crompton and Co. not long since sent out a small lighting plant for the Round Hill Syndicate in New Zealand, and it is said the lighting has been very effective. A Pelton waterwheel is used in this installation.

Taunton.—There have been some lively doings at the Taunton Town Council at the last meeting with reference to the electric lighting question, for the ground swell after the storm does not seem to have subsided. Alderman Standfast caused a scene at the previous Council meeting, the Mayor left the chair, and the meeting was broken up. At the Town Council meeting the Electric Lighting Committee reprimanded the vigorous alderman, who explained his version of the affair, and a vote of confidence in the Mayor was finally passed. The Council further presented a letter received from the Laing, Wharton, and Down Syndicate as follows: "London, August 18, 1892. Dear Sir,—The various reports which have been made by Mr. Gisbert Kapp upon the electric lighting installation in your town have come to our knowledge, and inasmuch as the electrical apparatus is all on the Thomson-Houston system supplied by us, we feel that we should have an opportunity to contradict the erroneous statements as to our system contained therein. We therefore propose to request a professional gentleman of undoubted partiality [impartiality?] to make a report which we will submit to you for presentation to your Town Council. We would therefore ask you to be good enough to let us know what names you would suggest, or, as we understand, that certain names were suggested to you by the Board of Trade, we would ask you to let us know those names, in order that we may choose a gentleman who would be acceptable to the Town Council and to the Board of Trade.—Yours faithfully, The Laing, Wharton, and Down Syndicate." The town clerk replied as follows: "Taunton, August 27, 1892. Dear Sir,—Your letter of the 16th will be laid before the Council at their meeting on the 13th Sept. My own idea of the matter is that the Council will decide not to interfere with your choice of a professional man to report upon your system of electric lighting in Taunton beyond affording the gentleman all information in their power. In reply to your question as to the names given to the Corporation by the Board of Trade at our request I must call your attention to the fact that a valuation was the principal matter upon which we required assistance; the report on the existing system was a necessary portion of the valuation. The gentlemen were Mr. Alex. P. Trotter, who did not consider valuing as part of his work, Mr. Alex. Kennedy, whose experience did not lie in valuation, and Dr. Fleming, whose fee was considered to be too high. The report of your scientist will of course receive the most careful consideration of the Council, but I do not think that they should give any opinion as to who he should be.—Yours respectfully, Thos. Meyler." The Mayor remarked, with reference to the opposition to the electric light, that it was all a question of £ s. d. The same objection was urged against the purchase of the water works, but they had made a profit of £800 a year. Councillor Adams seconded the committee's report, which, after some discussion on the Standfast incident, was adopted.

Hanley Electric Lighting.—The general supply is high tension alternating current plant, with transformers at sub-stations, and low tension distribution in the compulsory area. The following is a condensed summary of the contract with the Brush Electrical Engineering Company: Four Lancashire boilers, each 29ft. by 7ft., steam pressure, 140lb. Five vertical compound condensing engines—namely, three 200 i.h.p., and two 100 i.h.p., at a steam pressure of 120lb. Five alternators—namely, three 100 unit, and two 50 units, driven from engines by ropes. Separate vertical engine and dynamos for exciters. Separate compound engine for air and circulating pump and surface condenser. Each alternator, each exciter, and each circuit is equipped with complete switchboard. Primary mains, two lines of cast-iron socket pipes, into each of which a concentric cable is drawn from generating station on canal side to the compulsory area, together with a third line of cast-iron pipes for future requirements. Primary ring main of the same character embracing five transformer points and 10 transformers, within the compulsory area. Low tension distributing mains laid throughout the streets scheduled in the compulsory area comprises a small cast-iron trough with cast-iron lid, with two separate insulated cables embedded therein in bitumen. Total, £13,964. Street lighting within compulsory area contract includes 20 2,000 nominal candle power Brush direct current arc lamps and posts, one switchboard, two dynamos (each capable of developing 12,500 watts), two vertical compound steam engines having cylinders 6in., 10in. and 8in. stroke. Two miles 640 yards copper conductor insulated with vulcanised rubber and braided, and drawn into wrought-iron pipes, with all necessary fittings as specified. Total, £1,796. Total for general supply and street lighting, £15,760. The borough contains 1,788 acres, and is about equal to a circle having a radius of 1,650 yards. The electric lighting order compulsory area is the district between the Town Hall and the covered market, and contains 35 acres, and is about equal to a circle having a radius of 230 yards.

Abstract of Tenders Received.

Schemes utilising canal side for generating station Value of land 6s. per square yard; distance 800 yards

High tension continuous current plant with continuous current transformers to a low tension distribution in the compulsory area.

1.	The Electric Construction Corporation	£21,979

High-tension alternating current plant with transformers on customers' premises.

2.	Messrs. C. A. Parsons and Co.	19,100

High tension alternating current plant with transformers at sub stations and low tension distribution in the compulsory area.

3.	—	
4.	Messrs. J. G. Statter and Co.	18,517
5.	Messrs. J. E. H. Gordon and Co.	17,296
6.	The Laing, Wharton and Down Construction Company	15,690
7.	The Westinghouse Electric Company	14,526
8.	The Brush Electrical Engineering Company	13,964
9.	Messrs. J. D. F. Andrews and Co.	10,115

Schemes utilising land in Percy street for the generating station. This land is within the compulsory area, and is in the centre of the town, and valued at £3 per square yard. No water for condensing. Coal must be carted.

Low tension continuous current plant with accumulators.

10.	Messrs. Paterson and Cooper	20,500
11.	Messrs. Johnson and Phillips	19,350
12.	The Electric Construction Corporation	17,514
13.	Messrs. Sharp and Kent	14,150
14.	Messrs. Crompton and Co.	13,000

Low tension continuous current plant without accumulators.

15.	Messrs. Siemens Bros. and Co.	15,430
16.	Manchester Edison Swan Company	12,140
17.	Messrs. Woodhouse and Rawson	8,750

Schemes utilising land adjoining town yard for the generating station. Land valued at 6s. per square yard; distance, 400 yards. No water for condensing. Coal must be carted.

18.	Messrs. Siemens Bros. and Co. (low tension)	18,350
19.	Messrs. Johnson and Phillips (high tension)	17,550

All tenders for a total output of 400,000 watts except No. 17, which is for 300,000. The horse power varies from 450 to 800. All the low tension schemes, except No. 12, are on the three wire system. Nos. 2, 13, 14, 19 use Willans engines. Nos. 1, 3, 4, 15, 18 use horizontal engines. No. 2 uses the steam turbines coupled direct to alternators. Nos. 1 to 9 are all condensing. No. 3 withholds permission to publish. No. 9 does not include for transformers.

Street Lighting Tenders.—The tenders invited were for 20 arc lamps, distributed in the compulsory area. Some tendered for an entirely separate plant, the arc lamps being lighted and extinguished from generating station. Some tendered for alternating current lamps, controlled from a transformer station within the area. Some tendered for no separate system at all, but taking the electricity from the nearest general supply cable, and requiring the lamplighter to go round to light up or extinguish. In each of these classes there were variations, some including both arc lamps and posts, some including lamps but not posts, and others excluding both. As no fair comparison could, under these circumstances, be made, it is not desirable to publish the list of tenders.

PROVISIONAL PATENTS, 1892.

SEPTEMBER 12.

16284. **Improvements in electric call bell indicators.** William Jennings, jun., Victoria street, St. Albans, Herts.

16290. **Improved method of and means for supplying electricity to the carbon electrodes employed in the electrolysis of fused electrolytes.** Hans Heinrich Frei, 46, Lincoln's Inn fields, London.

16301. **Improvements in electrical fire and burglar alarm connections.** Homer Tong Wilson and Nathan Schwab, 77, Colmore row, Birmingham. (Complete specification.)

16315. **Improvements relating to electric telegraphs.** Frank Eustace Watkins Bowen, 6, Bream's buildings, Chancery lane, London.

SEPTEMBER 13.

16335. **Improvements in electric telephones.** Edward Marshall Harrison, Monument chambers, King William street, London. (Complete specification.)

16371. **Improvements in electric locomotives.** William Henry Soley, William Washington Perkins, James Wolstencroft, William O'Neill, and William Henry Yelland, 78, Fleet street, London. (Complete specification.)

SEPTEMBER 14.

16434. **Improvements in the construction of electric light switches, cut-outs, ceiling plates, wall-connectors, lampholders and the like.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Station Electrical Works, Salford, Manchester. (Complete specification.)

16458. **Improvements in or relating to ammeters and voltmeters.** Ernest Francis Moy and Francis Teague, 133, Strand, London.

16461. **Improvements in secondary batteries.** William Main, 6, Bream's buildings, Chancery lane, London. Date applied for under Patents Act 1883, Sec. 103, 15th February, 1892 being date of application in United States. (Complete specification.)

16469. **Improved contact fittings for movable electric lamps.** Charles Edmund Webber, 70, Chancery lane, London. (Complete specification.)

SEPTEMBER 15.

16489. **An arrangement for working an electrical rock drill or similar apparatus.** Albert Lester Taylor, 36, Dale street, Liverpool.

SEPTEMBER 16.

16545. **Improvements in and relating to dry and other galvanic batteries.** Alfred Ernest Joseph Ball, West Hoe, Plymouth.

16550. **Improvements in electric telegraphs.** Johannes Frydendahl Hjalgaard, 17, St. Ann's square, Manchester. (Hans Peter Fryd, Denmark.)

16561. **Improvements in dynamo-electric machines and motors.** Alexander William Meston, 55, Chancery lane, London. (Complete specification.)

16570. **An improved method and apparatus for electrical propulsion of vehicles.** Francis Edward Elmore, 28, Southampton buildings, Chancery lane, London.

16571. **Improvements in the connections of electric motors with the sources of electricity from which they are supplied.** Woodhouse and Rawson, United, Limited, and William Stepney Rawson, 28, Southampton buildings, Chancery lane, London.

16588. **Production of oxygen and hydrogen by electrolysis of water.** Pompeo Garuti, 24, Southampton buildings, Chancery lane, London. (Date applied for under Patents Act, 1883, Sec. 103, April 25th, being date of application in Italy.)

SEPTEMBER 17.

16614. **Improvements in and relating to advertising by means of electric light.** P. and Robert Lease Rossman, 70, High street, Southampton.

16615. **Improvements in connection with electric incandescent lamps and holders therefor.** Thomas Froggatt, 4, Moorfields, Fore street, London.

16624. **Improvements in automatic electric winding mechanism for electricity meters operated by the aid of clockwork mechanism and for clocks.** George Wilson Fairall, 56, Chancery lane, London.

16644. **Improvements in instruments for measuring electrical currents.** Siemens Bros. and Co., Limited, 28, Southampton buildings, London. (Siemens and Halske, Germany.)

16650. **Improvements in or appertaining to electric light fittings.** Frederick William Plumstead, 124, Chancery lane, London.

SPECIFICATIONS PUBLISHED.

1891.

17119. **Electrical switches.** Cheesewright.

18044. **Telephone switchboards.** Whalley.

18251. **Electricity meters.** Siemens Bros. and Co., Limited, and Baily.

18595. **Electric circuit controller.** Cleveland.

18524. **Electric conductors.** Thompson. (Hewett and another.)

19225. **Electrical indicator.** Siemens Bros. and Co., Limited, and Schlocher.

1892.

7404A. **Dynamo-electric machines, etc.** Short.

10457. **Electric resistances.** Schneider.

13549. **Dynamo-electric machines.** Andersen.

13648. **Electric railways.** Dewey.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	Price Wednesday
Brush Co.	—	$3\frac{1}{4}$
Pref.	—	$2\frac{1}{4}$
City of London	—	$14\frac{1}{4}$
India Rubber, Gutta Percha & Telegraph Co.	10	$20\frac{1}{2}$
House to House	5	$5\frac{1}{4}$
Metropolitan Electric Supply	—	7
London Electric Supply	5	$\frac{1}{4}$
Swan United	$3\frac{3}{4}$	$3\frac{1}{4}$
St. James	—	8
National Telephone	5	$4\frac{3}{4}$
Electric Construction	10	5
Westminster Electric	—	6
Liverpool Electric Supply	5	4
	3	$3\frac{1}{2}$

NOTES.

Dolgelly.—The streets of Dolgelley were lighted up for the first time last week.

The Long-Distance Telephone between New York and Chicago is nearly completed.

Aldgate.—An electric light is to be placed on that old and venerated landmark, the Aldgate Pump.

Leicester.—The Leicester Gas Committee hope to deal with the electric lighting question at their next meeting.

Brooklyn.—The new Brooklyn electric power station is to have 14 Allis engines with an aggregate of 20,000 h.p.

City of London.—It will be noticed that the share list for the City of London Electric Company's fresh issue closes to-day for both town and country.

Algeria.—The town of Guelma, in Algeria, is now lighted by electricity, the installation having recently been completed by the Société Franco-Algérienne d'Electricité.

Indian Telegraphs.—Owing to the floods, it has been found impracticable to carry out the construction of the telegraph on the Chin Hills in India, and the work has been put off for a month or two.

Armature Removal.—Dynamos are now made, on the design of Stephen H. Sharpsteen, in America with tracks and travelling hangers on the dynamo frame for the easy removal of the armature for repair and inspection.

Mining Locomotives.—The Thomson Van Depoele Company are making great progress with electric mining locomotives. They have already no less than 11 of these engines at work in gold, silver, copper, iron, and coal mines.

Budapest.—The Budapest electric street railway has been such a success that we hear it is proposed to clear out the whole of the horse cars and erect a large central power station to drive all the cars in the town by electricity.

Electric Traction at Work.—In Minneapolis, where the electric trolley tramcar service is in full work, there were 26,500,000 passengers carried electrically last year, and the return for the present year is many per cent. higher still.

Southend.—Messrs. Crompton and Co. have made a report on the electrical works connected with the Southend Pier. Everything is in good order except one or two details, but they recommend a thorough inspection at the end of the season.

Ventilation of Batteries.—Captain Khotinsky states that by a special device he has been able to do away with all trouble from acid fumes in storage batteries, so that cells in ordinary use can be placed in a close cellar or other room without special ventilation.

Calcutta.—The lighting of the Harrison-road, Calcutta, has been experimentally carried out with success. The whole installation will cost, when complete, that well known sum "a lakh of rupees." The road will have 36 arc lamps of 1,200 c.p., with duplicate sets of engines and dynamos.

Guildhall.—The electric light was tested in the Press gallery in the Council-chamber at Guildhall last week, and the result of the experiment was considered highly satisfactory. In due course it will be introduced into other parts of the chamber instead of gas, and the whole of the Guildhall will eventually be so lighted.

Lightning Conductors.—We have received, in the "Specialist Series," from Messrs. Whittaker and Co "Lightning Conductors and Lightning Guards," by Prof. Oliver J. Lodge, the expansion of his well-known lectures before the Society of Arts in 1888, with appendices and illustrations, now issued in volume form.

Brown Dynamos.—M. Jean Jacques Heilmann, who is licensee for dynamos on Brown, Boveri, and Co.'s patents, has joined Messrs. Weyher et Richemond, of Pantin, to carry on the construction of these dynamos in France. M. Weyher, the managing director of this company, is also a director of the Continental Edison Company.

Statue of Liberty.—The face of the gigantic statue of Liberty in New York Harbour is thought not to be sufficiently distinct at night, and a proposal is made to put an arc lamp with a reflector to throw the light on the features of the statue. Two 100 c.p. incandescent lamps would also be placed on each of the 25 rays of the coronet.

Divers' Lamps.—Search for sunken treasure is being prosecuted by electric light in Long Island Sound, near the rock known as Hell Gate, New York. Over 100 years ago the British warship "Hussar" was sunk here with bullion to the extent of a million pounds on board, and already the spot has been found, and bones and coins have been raised by the divers to the surface.

The Junior Engineering Society.—The Council have the gratification to announce that the presidency of the society for the twelfth session has been accepted by Dr. John Hopkinson, D.Sc., F.R.S., in succession to Sir Edward J. Reed. The new session will be opened by the delivery of Dr. Hopkinson's presidential address on Friday, 4th November, at the Westminster Palace Hotel.

Mining.—The Cumberland County Council have appointed a young, but clever and experienced, teacher, Mr. James Gunson Lawn, as their lecturer on "Mining" for a twelvemonth. He is the son of the manager of the Hematite Iron and Steel Company, and has had much experience in metallurgy and physics, and will carry on classes in Barrow, Whitehaven, Maryport, and neighbouring towns.

Aberdeen University.—Mr. Charles Mitchell, of Sir William Armstrong, Mitchell, and Co., Elswick Works, has, it is understood, offered to contribute a sum of from £10,000 to £12,000 towards the extension of Aberdeen University on condition that evening science classes for artisans are established, and that professors of agriculture and engineering are appointed. It is expected that the munificent gift will be accepted.

Khotinsky Plant.—Captain Khotinsky, now settled in America with the Germania Company, has bought and redesigned the Lahmeyer machine in different sizes, and is manufacturing the Khotinsky high-voltage lamp and the Khotinsky battery, which seems to be doing well. A special set is made up for villa lighting, consisting of a rotary windmill, regulating dynamo, and storage cell, which appears to be adopted successfully.

Lineff Traction System.—We have not heard much lately of Mr. Lineff's electric closed-conduit system. It is to be feared that the telephone clause was too hard. We have heard that Mr. Lineff himself has been in America, where he fancies there will be less scruple about using a practical closed-conduit system even if the leak to earth is noticeable on a single-wire telephone. There they consider the roads to be for the use of vehicles, and not for the benefit of a telephone company.

Electric Lighting of Towns.—Thomas Reid delivered his opening lecture to the class in electrical engineering and steam in the Technical Institute, Dundee, on the 19th inst., dealing with the electric lighting of towns. The lecturer described the three-wire system, house circuits, and methods of wiring, and finally dealt with the measurement of elec-

should be as free as possible, however, from sulphate of magnesia, and in the raising of the temperature of the bath to 55deg. C. The solution takes up 30 to 75 grammes of crystallised sulphate of zinc, and 150 to 300 grammes of alkaline sulphate per litre, according to the density of current. The following are the advantages claimed: (1) The conductivity is 300 or 400 per cent. higher than that of the electrolyte of sulphate of zinc alone of the density to furnish the greatest possible conductivity; (2) a current of any strength between 10 to 140 amperes per square metre of surface can be used; (3) using condensing steam engines, a ton of zinc can be extracted from this ore for as little as three to 3½ tons of coal.

Electric Launches on the Yare.—On the waters of the Wensum and the Yare at Yarmouth is now to be seen the first specimen of electric launches which have yet been run in these parts. The "Dolce Far Niente," which is the name of the boat, is one of an electric flotilla built by Mr. K. Bowen, of Maidenhead, the largest of which, now running on the Thames, is the saloon, "Ray Mead," 65ft. in length, and registered to carry 80 passengers. The "Dolce Far Niente" is an open boat, 27ft. in length, constructed of Burmese teak, and is capable of carrying 10 passengers with the greatest comfort. A novelty in the seating arrangements is employed in the use of wicker lounge chairs. The storage cells are placed beneath the flat floor of the boat, and are capable of giving current for a run of seven hours, or a journey of 60 miles. The propeller speed is 450 revolutions per minute. The motion of the boat is delightfully easy and pleasant, and it is only likely to be the precursor of a large number of electrical boats on the smooth waters of the Norfolk Broads.

Electric Towing.—We have alluded to recent attempts to put in practice the idea of towing canal boats by electric traction, and we now notice that experiments in this direction have been made on the Saint-Maur Canal in France by a M. Levy. In these experiments, however, instead of a propeller, the method employed on the Neckar was used, of a continuous chain lying at the bottom of the canal, which is picked up and passed over a pulley on the barge. The pulley in this case was driven by an electric motor on the boat supplied with current from a trolley wire carried on posts along the bank. This seems rather a roundabout way of attaining the end, but in canal practice it is most necessary to do away with the wash of the water against the bank, which paddles, or even propellers, cannot help producing. It will be interesting to see if the chain-pulling electric barge will prove a commercial success, as it is perfectly certain a far larger proportion of heavy transport might well be given over to canal traffic if a cheap and efficient means of traction were provided.

Electric Voting.—In this age of hurry, the loss of time which occurs in all legislative assemblies over the process of voting has caused various inventors to dream of the possibility of inventing a practical electrical voting apparatus. Doubtful as it is whether the stream of members into the "aye" and "no" lobbies will be likely to cease for some time in the British Parliament, it is none the less probable that in America and in Japan—where modern ideas are prevailing—that some such an apparatus will be regularly adopted. A Japanese inventor has been working for some time on such an electrical voter with considerable success, and there is no real reason why it could not be adopted. Each member has a push button and wire locked with his own key. An electric contact releases a red ball according to contact in two directions, and when the names are noted the balls are run down into rows of 10, and counted up and sent back to their position all by electric means. A secret vote is taken by drawing down a blind and running all the balls into a receptacle, counted, and sent back without possibility of seeing who has voted.

Electric Launch.—The trial trip of an electric launch named the "Vashti" was made the other week on the Hudson river. A run of 18 miles was made in 2½ hours most satisfactorily. The boat measures 30ft., beam 6ft. 6in., with a draught of 2ft. She seats 26 persons comfortably, is driven with a 5-h.p. motor, taking only 4 h.p. usually in running, driving the propeller at 400 revolutions a minute, and making easily 8 miles an hour. There are 72 cells with a capacity of 345 watt-hours each. The motor weighs 630lb. and the cells 37½lb. each. The propeller is 20in. diameter and of 20in. pitch, developing great power with few revolutions. The switch is constructed in the form of a wheel, with the various speeds, stopping and reversing motions performed by degrees of rotation of the wheel in a very convenient manner. A peculiarity of the batteries is the substitution of zinc for lead in the negative poles, which, says Prof. William Main, electrician to the Union Electric Company, gives a higher voltage with less weight, and is a step towards the solution of light efficient traction batteries. It is expected other boats will be built on the lines of the "Vashti" for plying on the Hudson.

Cost of Electric Transmission.—A report of M. Comberousse, on behalf of the Chemical Arts Committee of the French Société d'Encouragement, upon the proposed prize of 3,000f. for the transmission of natural forces to a distance, and the proposal to award the same to M. Hillaret, contains the following observations: "A fresh increase in the cost of coal was on the point of preventing the Moutier Paper Mills from standing their ground against competitors who obtained their motive power from neighbouring waterfalls. It was this that led the owners to the adoption of electrical transmission of power, the installation for which was completed at the end of September, 1889, and put into operation without stoppage of the works. The generating dynamo, driven direct by a turbine with horizontal shaft, is put into communication with two overhead conductors, which carry the current to a motor at the works. The generator is one of 300 h.p. at 240 revolutions, and the motor represents 200 h.p. at 300 revolutions per minute. The length of the line is five kiloms. (three miles), and the maximum E.M.F was 2,850 volts, with a maximum current of 70 amperes. The annual expense of the electrical transmission is 18,750f. (£750), against 57,906f., which is the estimated cost per annum of an additional engine."

Thames Valley Towns.—Proposals are being made for lighting by electricity the various riparian towns of the Lower Thames valley. Activity at the present moment has been provoked by the action of the Brentford and Richmond Gas Companies in giving notice of an increased charge of 3d. per 1,000 cubic feet in the ensuing quarter. The Richmond Town Council have sealed a contract with an electric lighting company, and the works are already in progress. The Chiswick Local Board have applied to the Board of Trade for their sanction to a contract with Messrs. Bourne and Grant for the electric lighting of the parish, and the contractors are ready to proceed. The Twickenham Local Board at their meeting a few days ago passed a resolution of protest against the extra charge, and referred to the Lighting Committee the consideration of some other mode of lighting the town. The Heston and Isleworth Local Board, which have the largest area of any urban sanitary authority

in the kingdom, also recorded a protest against the increased imposition, and warned the Brentford Gas Company that if proceeded with the Board would consider the question of lighting the district by electricity. The Brentford Local Board have hitherto confined themselves to protest, but the feeling among the members, says the *Times* of last Monday, is so strong that they are not unlikely to follow the example of their neighbours.

Dublin.—The Dublin Corporation, after long and severe tests, have taken over the electric lighting plant. Last Friday afternoon the Electric Lighting Committee met in the works to formally take over the work from Messrs. Hammond, the sub-contractors. Mr. J. Robinson, the chairman of the Electric Lighting Committee, was present, and was accompanied by Mr. Spencer Harty, borough engineer; Mr. Beveridge, town clerk, and several others. Mr. Robert Hammond, of the firm of Hammond and Co., handed the key over to Mr. Haslam, the representative of the Electrical Engineering Company of Ireland. With an appropriate speech, Mr. Haslam in his turn handed the key to Mr. Spencer Harty, C.E., upon which the works passed into the possession of the Corporation. The lighting thereafter has been carried on by the Corporation, who have taken over the staff and leading officials. All the gas lamps have been turned off in the streets where the electric lamps are fixed. The lighting was a great success, most of the principal thoroughfares of the Irish capital being now fully and brilliantly lighted. The only private building lighted by the Corporation on the first night was the Hotel Metropole, but a considerable number are now being connected. The officials of the Hotel Metropole, from their experience of the last three weeks, speak highly of the light. Mr. Mark Ruddle will, we understand, superintend the station for the Corporation.

Finsbury College.—We have been requested to announce that the available places in the electrical laboratories of the Finsbury Technical College are already filled for Monday and Wednesday evenings of the present winter session. Applicants for attendance at the lectures only can be admitted, but there are still some vacancies in the overflow class in the laboratories on Tuesday nights. The evening ordinary lectures at the Technical College will be resumed on Oct. 3. In the advanced course on Mondays Prof. Thompson will lecture on "Dynamos and Motors," the introductory lecture on Oct. 3 being on "Magnetic Fields." The Wednesday lectures will begin with "Magnetism and Measuring Instruments." On Thursday, October 6th, Mr. G. H. Robertson, F.C.S., will commence a short "special" course of lecture on accumulators, dealing mainly with the chemical questions to which he has given so much attention. Another of the Finsbury specials is a set of four lectures by Prof. Perry, F.R.S., on gas and oil engines, which commences on November 7th, and is continued on successive Thursdays. After Christmas, Prof. Silvanus Thompson will give another short course on central stations. Throughout the winter Prof. Perry will hold a Friday night class on the applications of higher mathematics in engineering, illustrated by examples from mechanical, hydraulic, and electrical engineering. Mr. Rousseau will commence in January the course of practical instruction in the electroplating laboratory.

Belfast.—The mills, already large, of the Cogry Flax Spinning Company have recently been greatly enlarged and lighted throughout by electric light. The installation, which was one of the first in the trade, is one of the most successful in the North of Ireland, and the greater part of the work has been carried out by the mechanical staff of the mill. The dynamos are driven by the ordinary p[illegible] and there is sufficient spare water power to give a splendid light everywhere free of cost, except for lamps and repairs. The yard entrance has a 1,600-c.p. arc lamp, while throughout the building are placed incandescent lamps; and the private house of the proprietor, Mr M'Meekin, on the bank of the river near by, is also lighted from the same installation. The operatives bear strong testimony to the healthiness and comfort of the light. The *Belfast News Letter*, commenting recently on the lighting of the Cogry Mills, says: "It is, perhaps, the finest specimen we have yet witnessed of electric lighting, and we understand has so impressed all millowners and managers of large works who have seen it that experiments of a similar nature are pending. Those who have tried it before and relinquished the idea are, we understand, again in the field, especially companies whose manufactories occupy suburban situations. Mr. M'Meekin speaks highly of its application in the linen trade, and asserts in the most unqualified manner that its introduction in all large concerns of the kind is a matter of only a very short time."

Pure Platinum.—The quantity of platinum extracted in Russia during 1891 was 258 poude, a poud being 35lb., this makes a total of about four tons. Platinum is extracted by private companies, which are obliged to pay a royalty of eight pouds of raw platinum containing 80·59 per cent. pure metal. As the poud is worth 5,000 roubles, the total quantity extracted in 1891 amounted to a million and a quarter roubles. These figures give some idea of the costliness of the present methods of extraction. A simple and less costly method than that generally employed has been published by M. Finkener, using the successive crystallisations of the double chlorides of platinum and sodium. To the platinum of commerce dissolved in hydrochloric acid is added the calculated quantity of chloride of sodium to give, after concentration and cooling, crystals of double chloride. The water is poured off and the crystals washed in a concentrated solution of chloride of sodium, and redissolved in a 1 per cent. solution of carbonate of soda. Cooled again, the solution deposits crystals of pure double chloride, which is dried at 120deg. and reduced in a current of hydrogen. There are very few absolutely pure specimens of platinum. The commercial metal has many impurities, such as small quantities of iridium, ruthenium, rhodium, palladium, iron, copper, silver, etc. When it is remembered how greatly small impurities affect the properties of almost every metal, the simple process of M. Finkener is likely to facilitate researches on pure platinum.

Accumulator for Traction.—Mr. Weyde-Elsner describes (says the Institute of Civil Engineers' *Abstracts*) the various properties which a good type of cell ought to possess, and remarks that such cells are subjected to very rough usage in traction work. They should be able to discharge very large currents, and should be as light as possible. The new cells differ in many respects from those most in use in this country. Long thin channels of celluloid are used as supporting frames. The cross-section of the channels is approximately one-third of a circle. The active material consists of peroxide of lead, and it is pressed into solid short cylinders as hard as the carbon for arc lamps; each cylinder has a hole along its axis, and they are all "formed" before being placed in position. They are then coated with a special conducting cement, and laid at a short distance apart inside two channel-shaped strips of sheet lead, each of which is provided with a wide lug at one end. Each set of five cylinders, with the lead conducting strips, are then placed inside a pair of celluloid channels. About eight of these complete sets are then mounted vertically, and held together by

bands of celluloid. Celluloid tubes also pass through holes at each end of the celluloid channels. The whole is held firmly together by wooden wedges. All the lead strips are then soldered on to one common bar, and the compounds form either the positive or negative plate in a cell. It is claimed that the construction is solid, and that only the thin lead conductors on the positive plates deteriorate, and can easily be renewed.

Telephones in India.—The Indian Telegraph Department have made great strides in the past year in the establishment of telephone exchanges in our large inland towns, says the *Indian Engineer*, and they hope still further to extend the benefits of telephony very soon. The public, so far, have not realised what improvements have lately been made in telephones. The older instruments were constantly getting out of order, and those who paid for their use soon grew weary of constantly calling upon the department to put them in working order. Now, however, there are scarcely any complaints where exchanges are at work. In order to still further popularise the use of the telephone, Mr. Brooke, Director-General of Telegraphs, has recently obtained from England a large number of instruments of the British Post Office pattern. These are simple in construction, absolutely reliable, and reproduce words spoken into them with a distinctness which is little short of marvellous. They are as much in advance of the original instruments used in India as the Magazine rifle is of the Snider. The "Berliner" telephone made in Hanover, is also being tried experimentally. This is a most ingenious instrument, the words being heard even when the earpiece is held some inches away. Its mechanism is somewhat delicate, but the Berliner must have a great future before it. In India the telephone should be largely employed, not merely in commercial centres, but in all towns and cantonments for linking up police posts, courts, treasuries, public offices, and the like with each other, and, in some cases, with the houses of civil and military officials.

Nottingham Technical Schools.—The new technical schools added to the Nottingham University College are approaching completion, and will be opened in about a month. The master and warden of the Drapers' Company will be at the opening, assisted, amongst others, by Prof. Perry, who will give an address, and it is hoped for the presence of Sir Albert Rollit, president of the Chamber of Commerce. Classes are already in process of organisation, and there are now about 50 day students and about 1,000 evening pupils actively pursuing their studies in the various departments, while in that devoted to electrical science they are enabled to obtain practical training by assisting in the wiring and erection of the installation for lighting the whole of the new buildings by electricity. Messrs. Manlove and Alliott, of Bloomsgrove Works, Nottingham, have erected in the new building an experimental engine at a cost of upwards of £500. The engine will drive the machinery in the workshops in ordinary working, and is adapted to be arranged in a variety of ways for experimental purposes. This firm has generously contributed 200 guineas of the cost of this fine machinery. The Technical Education Committee have received the hearty co-operation of various engineering firms in the country, the result being that about £4,000 worth of machinery is being put in at a cost of £2,400. This is in addition to the fittings in the old temporary shops, all the shop tools and machinery being utilised in the new shops. The senior electrical students are actively engaged under Prof. Robinson and a foreman from the Brush Company on the electric installation, and a high-speed engine, with the requisite dynamos, are being placed in position. These were supplied by the Brush Company, who have also made a liberal allowance off the cost for the purpose of promoting the cause of technical education, only charging £600 for a plant which is estimated to be worth £1,000. It is intended that the lighting shall be in the hands of the students, who, under the direction of the professor of engineering and staff, will take entire charge of the plant, and keep it in working order. In the lecture-room the furniture and fittings will be on the most approved principles, and this remark especially applies to the blackboards, which are constructed in conformity with the model of those at Finsbury Technical College, which have an ingenious mechanical arrangement for raising and lowering them to suit the convenience of the lecturer. These boards were designed by the late Prof. Thomson, brother of Lord Kelvin. The entire construction of the building has been carried out under the superintendence of Prof. Robinson, who has given great care and thought to the arrangement of the technical details.

Lamp Vacua.—M. C. Boccali has investigated this question. His method is to take a petroleum bath kept at a temperature of 68deg. F., and noting the current required to raise the temperature of the filament to 122deg. F. For this purpose an arrangement of Wheatstone bridge and galvanometer is used, which is described in detail. The bath is first heated to 122deg. F., and the resistance, R, of the filament is taken; this must be obtained with a current of about 0·3 milliampere, so as not to heat the bath. The bath is then cooled to 68deg., and the resistance of the filament remaining the same, the current, C, is noted. This value C represents the current which is required to heat the filament to 122deg. F., while the surrounding temperature is 68deg. The resistence, *r*, is that of the filament at 68deg., and is obtained with a current of 0·3 milliampere.

Lamp No.	Ohms. *r*.	Ohms. R.	Milliamps. C.	Milliwatt. R × C.	*a*.
1	182·9	178·0	6·64	7·85	186
2	169·8	164·8	7·24	8·64	183
3	188·6	183·5	7·14	9·52	176·5
4	161·7	157·4	7·81	9·60	182·5
5	159·4	155·6	9·00	12·60	180·0
6	165·8	161·2	9·20	13·61	173 0
7	172·0	167·4	9·40	14·80	168·5

The table gives the results of experiments made upon seven lamps of 65-66 volts and 16 c.p. of the same type and by the same makers. It appears, therefore, from these tests that No. 1 lamp is very much the best, as it required only 7·85 milliwatts to heat it to 122deg., while No. 7 required about double. The difference in resistance of the filaments is not 9 per cent., and is not enough to account for the figures R × C. The results are therefore caused by differences in the vacuums of the lamps. A check test was made by a different method. In order to obtain equality of temperature inside and outside the lamp, a certain time is necessary, and the better the vacuum the longer the time needed. The exact time is difficult to measure, but for a series of lamps figures can be obtained which depend upon the time. In place of the lamp, a resistance equal to its resistance at 122deg. is inserted, a current, C, is passed through, and the throw of the galvanometer made equal to, say, two hundred scale divisions. The lamp is now inserted, and the throw observed; this will always be less than 200, and will vary according to the perfection of the vacuum. In this way the figures in column *a* were obtained; these all agree with the other results, except that for lamp No. 3, and the discrepancy in this case is due to the fact that the filament was much out of the centre, and near to the glass globe at one point.—*Abstracts* I.C.E.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

II.—MOTIVE POWER.

(Continued from page 316.)

COAL AS FUEL.

It is the sun that, through its rays of heat energy, causes trees, plants, and other vegetable and organic matter to spring out of the earth, grow, flourish for their allotted time, afterwards to gradually decay and die off; decomposition then sets in, and the matter sinks into the earth whence it came. The unceasing action of the sun's energy brings forth a fresh supply of living vegetable matter to take the place of the dead; this in its turn decays and dies after its season, and so layer after layer gets buried deep in the earth, each layer passing through successive chemical changes, due partly to the internal heat of the earth, etc. In this way coal is formed. The existing coalfields have been formed from decomposed plants and herbaceous matter that flourished as great primeval forests in ages so remote that the lapse of time may be counted as millions of years at this early period of the earth's division into land and water. We have every reason to imagine the soil entirely covered with a dense and luxuriant growth of ferns, reeds, grass, etc., of a gigantic size, the soil being partly submerged in water, thus forming huge swamps. This extraordinary carboniferous age is attributed to the humidity of the soil and the warm or possible tropical climate that was likely to exist at that time in places which are now temperate or frigid. No human being or animal could have lived in this vegetable world in the midst of vapours evolved by the decomposing matter. The only animal objects that inhabited the earth being, as far as we can tell, curious forms of reptile, fish, and such like imperfect organisms.

It is easy to see how the heat energy of the sun is transferred into coal, in the form of latent or stored heat, which ages after becomes liberated upon the coal being burnt. This provides one of the most beautiful examples there is of the conservation of energy. Living plants and vegetable matter derive their food from the atmosphere, absorbing the carbonic acid gas, or carbon dioxide (CO_2), that is present. The sun expends part of its heat rays in decomposing this gas—that is, its warmth acting on the delicate leaf cells, has the effect of splitting up the carbon dioxide into its component parts, namely, carbon and oxygen—so that every molecule of CO_2 is split up into one atom of carbon and two atoms of oxygen. Now, to tear away the oxygen atoms from the carbon atom, or, in chemical parlance, to overcome their chemical affinity, requires a great amount of energy, and since energy is a form of heat, hence a great deal of heat must be expended by the sun to do this. The oxygen atoms being set free, the carbon atoms remain behind to form the structure of the plant; this is why all woody matter, etc., consists greatly of carbon. The first opportunity that occurs, the carbon atoms join on to oxygen atoms, so as to regain their condition as CO_2. When oxygen and carbon combine they always evolve great heat, so when coal or any other carboniferous matter is burnt in the atmosphere, the carbon seizes hold of the oxygen in the atmosphere, and these combining give out such heat that the carbon atom is made incandescent, or white hot; this action being continuous, produces what we call flame. The flame of a candle is a hollow cone, the cone being formed by a thin film or envelope of glowing carbon. When the air supply becomes scant, the candle grows dim, simply because there is not sufficient oxygen present to combine with the carbon, consequently the latter only get partially consumed, and smoke is given off instead of a glow vapour. From this it can be understood that the heat given out by burning coal is exactly equivalent in amount to the heat that was expended in producing the coal. Returning, however, to the formation of coal, the first result of the decomposition of the vegetable matter is a produce called peat, a dark brown solid soil, the richer kinds being almost black. This peaty soil is found extensively in Ireland, in the swamps, marshes, and bogs with which that country abounds. The depth of the soil varies from a couple of feet to 50ft; the top layers are usually of a light reddish-brown colour, deeper down the hue changes to a dark brown, and still deeper it is almost black. As the depth increases, the soil, in addition, gets heavier and more solid, so that the surface peat is light and fibrous, and the black peat heavy and compact. It is used by the peasantry for fuel, after being first well dried. When thoroughly compressed and dried, it gives an evaporative power when burnt equal to one half that given by ordinary coal, comparing equal weights. It is a great deal used as boiler fuel in districts where it is obtained in quantity. The second stage produces "bituminous or common coal"; this after a while becomes harder and harder until the third stage is reached, when "anthracite coal" is produced. Any further lapse of time turns this kind of coal, which is the best, into fossilised coal, which is so hard that it is almost impossible to get it to burn. All organic matter contains carbon and hydrogen, and nearly all oxygen in addition, and all vegetable matter consists of carbon, hydrogen, and oxygen in various proportions, and having various chemical combinations according to the nature and structure of the plant, a few impurities, such as minerals, being usually present. Herbaceous matter contains more than 50 per cent. of carbon, about 5 per cent. of hydrogen, and more than 40 per cent. of oxygen. As it undergoes changes and decomposition, the oxygen decreases, whilst the carbon increases, and the more it progresses towards being formed into coal, so the oxygen decreases and the carbon increases, the hydrogen remaining fairly constant, except when bituminous coal changes into anthracite, and then it decreases.

The following table gives a rough idea of the composition of the coal-forming matter in four stages:

Element.	Wood.	Peat.	Bituminous.	Anthracite.
Carbon	52	60	75	93
Hydrogen	5	5	5	4
Oxygen ...	43	35	20	3

so that the best coal is composed of nearly all carbon.

1lb. of hydrogen completely burnt, evolves 62,032 heat units.
1lb. of carbon „ „ „ 14,500 „

One heat unit (British) is the amount of heat required to raise 1lb. of water from 60deg. F. to 61deg. F. = 1deg. F., and in mechanical energy it is equivalent to 772·5 foot-pounds. 1lb. of coal gives out about the same heat energy as 1lb. of carbon, hence 1lb. of coal when burnt will produce $772·5 \times 14{,}500 = 11{,}201{,}050$ foot-pounds of energy.

Let 1lb. of good anthracite coal, when burnt thoroughly, give out heat energy equal to, say, 11,000,000 foot-pounds—that is to say, an amount of energy sufficient to raise a weight of 11,000,000lb. a vertical distance of 1ft. One horse-power signifies 33,000 foot-pounds of work done in the space of one minute of time. If the coal be burnt in the space of one hour, this gives $\frac{11{,}000{,}000}{60}$ foot-pounds per minute, and dividing this by 33,000, will give $\frac{11{,}000{,}000}{60 \times 33000} =$ 20·2 h.p., so that burning coal at the rate of 1lb. per hour gives out heat energy equivalent to above 20 h.p., this being the total or theoretical energy given out. A great amount of this energy is wasted, and, roughly, only 50 per cent., or one half of it, can be said to be utilised. This useful half is employed to evaporate the water in a boiler, and the number of pounds of water that are converted into steam determines what is called the "evaporative power" of the coal, the steam being at an atmospheric pressure and at a temperature of 100deg. C. If the whole of the heat energy of 1lb. of coal were turned to account, it would evaporate about 15lb. of water; but since 50 per cent. of this is lost, therefore only 7·5lb. of water can be turned into steam, so that the efficiency of a boiler may be put down at 50 per cent.

The heat given out by burning fuel is called the "total or theoretical heat of combustion," and that portion which is utilised is called the "available or practical heat of combustion." The amount of heat evolved by coal depends a great deal on its quality and chemical composition. Carbon

and hydrogen are the valuable elements in fuel, and the percentage of these vary considerably. It need scarcely be said that the choice of coal for a boiler is most important and weighty, and becomes more so as the size and number of boilers increase. The coal bill is always the heaviest item in the working expenses of a central station, so it is natural that every buyer should try to obtain the coal that will give a maximum amount of heat for a minimum cost, taking care that the coal chosen is of a nature to suit the particular type of boiler employed.

The following table gives reliable and most careful analyses of the chief kinds of coal in Great Britain (compiled by Prof. W. Foster).

PERCENTAGE OF COMPOSITION.

Description of fuel.	Hydrogen.	Carbon.	Moisture	Ash.	Heat units per lb. of fuel
Welsh anthracite	3·5	89 17	1·78	2·12	15 017
Durham coal caking	5 3	84·31	1·14	2·42	15,221
Yorkshire coal ...	4·93	84 1	2 2	1 2	14,875
English cannel coal	5 02	81·46	2·07	5 8	14 571
Scotch cannel coal	6·18	75 42	4·0	2 24	15,750

Small quantities of nitrogen, sulphur, and oxygen are also present.

(To be continued.)

ON THE MANUFACTURE OF INCANDESCENT ELECTRIC LAMPS.

BY FREDERICK GRAHAM ANSELL, F.C.S.

(Continued from page 312.)

To flash in benzene, then, an air-tight vessel must be provided in place of H, somewhat like an ordinary air pump receiver, the electric wires must pass through the base plates, and a tube must be provided for exhausting the air and for letting in the benzene vapour. All mechanical arrangements should be avoided as far as possible, mercury pumps being much better, and, generally speaking, the better the vacuum the better the result of the flashing.

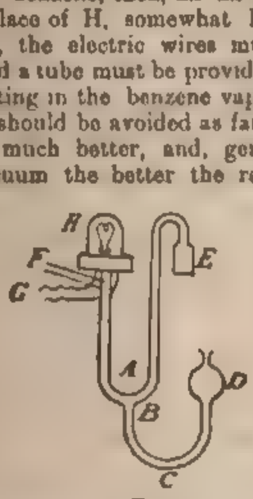

FIG. 5.

When the air is all out, the benzene vapour may be let in by lowering the mercury in a U-tube placed between the air pump receiver and the vessel containing the benzene, as shown in Fig 5, where E contains the benzene, H is the receiver with the filament inside, G the electric wires, A the U-tube, with a piece of indiarubber tube, C, joined on at B, and D is a funnel. F leads to the air pump. To start, E must be nearly full of benzene, and D low down, then pumping started, and when the vacuum is good the filament flashed. When the flashing is done, D must first be raised, so that mercury is well up the U-tube, A, and then, the air being let in slowly, the mercury will rise about 30in. in the tube leading to E. The next filament can now be mounted ready for flashing, H exhausted, and then D lowered for a minute or so, when H will soon fill with benzene; D can then be raised, the filament flashed, and the air let in very gently so as not to cause the mercury to rush over into E. It will now be seen that the U-tube, etc., acts as a virtual tap.

There are several other hydrocarbons which might be used for flashing, such as chloroform, toluol, cyniol, etc., but benzene gives the best results. A certain amount of practice will be found necessary before this rather delicate operation of flashing can be thoroughly well performed, and it is always advisable to keep the connecting joints between the platinum leading-in wires and the carbon filament as small as possible, otherwise they will not get hot enough to deposit carbon from the vapour of benzene or any other hydrocarbon.

We may now fairly suppose that our filament is complete, and can be given to the glassblower with instructions to join the glass upon which it is mounted as neatly as possible into the globe of the lamp. This operation will present no difficulty to a good glassblower. A small tube, A B, Fig. 2, will be required at the pointed end of the globe, to enable the lamp to be attached to the air pump. No indiarubber or mechanical joint will do for this purpose. The lamp tube must be blown on to the tube of the air pump, as shown in Fig. 6, which is a section of Sprengel's air pump—the best for our purpose. To put this pump in action, mercury is poured gently into the funnel, A, when by force of gravitation it flows up the other side of the U-tube to the horizontal tube, B, which is melted into a larger tube, C, in communication with a drying vessel, D, and the branches, E, on to which the lamps, F, are fused. The horizontal tube, B, is closed at the end, but has some small openings in its under side exactly over the tubes G, of which there may be any number—not less than, say, six. The mercury should be so fed into the funnel, A, that it shall fall through the openings in B in small globules down the tubes G, which must

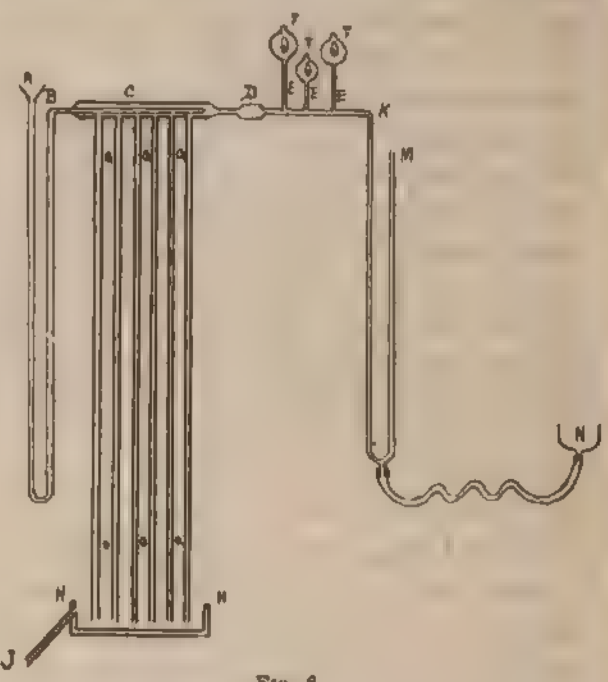

FIG. 6.

not be less than 36in. long, or of larger bore, then the globules of mercury will fall down the tubes G, and in doing so will take with them the air from the large tube, C, that from the tube E, and also from the lamps, F, etc. The bottom of each tube G must dip well below the surface of the mercury in the little trough, H, which must be provided with an overflow pipe, as shown at J, and must also allow the air to escape freely as it comes down the tubes G. The mercury must be caught at J, and so can be used over and over again. At first the mercury should be poured very slowly into A, because the large quantity of air between the drops of mercury as they fall into the tubes G causes them to descend slowly, and the operator will soon observe that at starting the pump works almost without noise, but as the vacuum begins to form a solid column of mercury begins to rise in G, and the globules falling on this will strike harder and harder. This sound, together with the height of the columns of mercury in the tubes G will afford an indication of how the exhaustion is

proceeding. When the columns cease to rise the pump should be stopped for a few minutes, and the height of the columns carefully noted in order to ascertain that there is no leak anywhere. The height of these columns must always be at least as high as the barometer at the time of the exhaustion, but, generally speaking, it will be higher than the barometer, because these pumps are exceedingly efficient. When no alteration in the sound of the falling drops of mercury has been observed for some considerable time, a small current of electricity, just enough to make the filament red, should be turned on, and generally this will stop the sound of the falling drops for a few minutes. When the sound has returned, a little more current may be turned on, and so on until a further addition of current makes no difference to the sound. In this way, the lamp should be raised somewhat above its normal brightness and the pump kept going all the time for about 20 or 30 minutes. The vacuum should then be sufficiently perfect, and the lamp may be disconnected by means of a hand blow pipe from the pump, but the filament should be kept fully incandescent during this little operation by the electricity. The current may then be turned off and the lamp will be complete. In taking a lamp from the pump, the operator must be very careful to heat the small connecting tube only just enough to enable him to draw away the lamp, as if the glass is made too soft the pressure of the atmosphere will be certain to force a hole through the glass, and then the lamp will be destroyed and the vacuum in the pump lost, but if the tube is only just softened by the blow-pipe flame all round, then there is no fear of this calamity with its lamentable waste of time. The author has generally observed that these pumps, although all made alike, vary a good deal in the length of time they take to get a good vacuum, and he would draw attention, in passing, to the interesting, though unimportant, fact that the drops of mercury in falling through the tubes G give rather pretty blue streamers of frictional electricity when the vacuum reaches and remains at a certain stage, but they disappear as the vacuum becomes really good. Of course, they can only be seen in the dark. Those who use these ingenious air pumps will also observe, to their sorrow, that the falling drops in the tubes G have a most unpleasant way of breaking the tubes. The only remedy is to seal the tube above the break, and then to replace it by a new one on the first convenient opportunity. In order to escape the poisonous vapour given off by the mercury, care should be taken in designing the pumps, etc., that as far as possible all the mercury should be kept in tubes and covered receptacles, the air escaping from the little trough, H, being led through a pipe into the outer air away from the operating-room, which must be kept well ventilated. Too much attention cannot be paid to this important matter, as it is a real danger, the author having known several serious cases of mercury poisoning through its neglect.

Referring to Fig. 6, which is arranged as simply as possible to show the principle of the pump, it would be a good plan to dispense with the funnel, A, to put a somewhat capacious covered vessel under J, and then to connect them by means of an iron plunger force pump. In the tube J and all similar places great care should be taken that the mercury does not fall, but runs down an incline. If this precaution is neglected, the mercury will in the course of a short time break itself up into an immense number of small globules, which adhere closely together in a soft pasty mass, and will be sure to block up any passage they may be in. Iron is the only metal suitable for use in contact with the mercury, as any other would be attacked and dissolved by it, and dirty or impure mercury would give trouble in the pump and elsewhere.

(*To be continued.*)

CARBONS.*

BY H. O. FISK.

It was suggested at one of our committee meetings that I should prepare a paper for this convention on carbon testing, but the time was too short to carry out a series of experiments as at first spoken of, so, instead, I have prepared a short description of the process of manufacture of carbon points as conducted at the factory in Peterborough.

Twenty five per cent. of gas coke mixed with 75 per cent. of petroleum coke is said to make a good carbon for low-tension work. Another variety of this material is obtained from the oil regions, commonly known as petroleum coke. This is a by product of the oil stills, and is the only kind used to any great extent in the manufacture of carbon points for the electrical industry. It is of primary importance that the coke, and, in fact, all the ingredients used, be absolutely free from impurities. The other constituent of our carbon is pitch. This is made from coal tar, which is a by product of the gas retorts. It may also be obtained from blast furnaces, but this kind is more or less contaminated with iron, and therefore is unfit for this class of work. Pitch for this particular purpose is difficult to obtain, as the makers do not care to expose their stills to the high temperature necessary to drive out all the oil and reduce it to the proper specific gravity, and, as the men in the factory say, "it is more or less wet."

The first step in the process of manufacture is that of crushing the coke. This is accomplished by means of a machine somewhat in appearance like a mammoth coffee mill. The coke comes from this crushed to about the size of coarse gravel, it is then automatically elevated to a large bin in the upper part of the factory, and from there it is conveyed to a large iron hopper situated directly over the calcining retorts. Into these the granulated coke is conducted by means of spouts with gates arranged to control the flow of material into the several aforementioned retorts. They are then sealed up, thereby preventing combustion, with the exception of a few vents to allow of the escape of gas arising from the heating of the coke to a state of incandescence, which point is reached in from 24 to 48 hours after firing. After this, if the coke is not pure it will be found to have caked, necessitating in some cases the use of bars to break it up sufficiently to allow of its being drawn from the retorts. If pure it will appear crisp and dry and to have suffered a loss in weight of about 30 per cent. After the retorts have been drawn sufficiently long to allow the cooling, their contents are elevated to the milling department and run through a set of French burr stones encased in iron, very similar to the grist mill chop stones, then through a silk bolter, separating the coarse from the fine, the former returning to the milling-machine, the latter being conveyed to bins with suitably arranged spouts over scales, from which it may be drawn and weighed as required by the mixing department. We will leave the coke here for the present and return to the other ingredient—namely, the pitch. This is dense, hard, solid, very brittle and dry, and in appearance somewhat resembling gutta percha. This material, when it reaches the factory, is encased in casks holding about 600lb. each. It is then broken up by the men into a convenient size for handling, and subjected to a granulating process similar to that of the coke, finally, we find it at a spout close beside the one from which the coke can be drawn.

We have now followed the two principal ingredients through the various processes which were necessary to prepare them for the mixing room. The other ingredients, if any, we shall not be able to elaborate upon until we have reached a more confidential relationship with the carbon makers. However, upon the manipulation of the materials at this stage I am told the success of the future carbon greatly depends, in fact, the great secret lies in the mixing. We can better understand the skill and care required to properly amalgamate the mixture when we learn that each particle or grain of coke must have its individual coating of pitch, and it may be interesting to learn that this coke is ground so fine that a grain magnified a thousand times would only appear the size of a shot. To obtain these results, the materials are carefully proportioned by weight and placed in a mixing barrel. This is a rotating cast iron cylinder within which, in the same direction, revolves an independent shaft twice as fast as the cylinder, to which are attached arms so arranged that every part of the barrel is covered or swept in each

* Abstract of paper read before the Canadian Electrical Association.

revolution. This is attached to a furnace in such a way that the flues follow the whole circumference of this barrel, maintaining a uniform temperature of about 300deg F., which is necessary to bring the pitch to a state sufficiently plastic for amalgamation. Thirty minutes is the time required for each batch, which would make about 1,600 carbons. From this machine it is taken to the cooling-room and spread out for 10 or 12 hours to cool. Here the mixture solidifies to such an extent that it becomes necessary to pulverise it again to perfect it for the moulds. This end is attained by means of a mill, the pulverising feature of which is two discs 30in. in diameter, with corrugated face plates revolving in opposite directions at the rate of 1,500 revolutions per minute (about one one-hundredth of an inch apart). From this it is once more passed through a bolting machine, and then, finding its way down gravity tubes to a bin on the floor below (which is the moulding-room), it is carefully weighed out by the workmen on peculiar little scales with clock-like dials, in quantities just sufficient to fill each mould as it comes hot from the oven.

The mould having been previously lubricated with some heavy oils, and now ready for its charge, which the operator places in it and works evenly over the whole surface with a spatula, to ensure uniformity of density, the cover or top half is placed in position, and the mould and its contents pass for a few moments into an oven, the temperature of which is about 300deg. F. As soon as the mixture has become quite adhesive, the mould is placed in the hydraulic press and subjected to a pressure of several hundred tons. The mould is now removed and opened, and we have a corrugated card containing 16 or 18 carbons, each one being joined to its neighbour by a fin which is inevitably formed when subjected to the enormous pressure before mentioned. These cards are placed on plates which are fitted to receive them perfectly. These plates with their contents are piled up, and weights placed thereon to prevent warping. When cool they are broken apart, gauged for size, culled, and the fin scraped off. They are then laid in the furnace for baking. This furnace is rectangular in shape, 34 by 11, 4ft. deep, and made of fire-brick, and is similar to a large vat set about two-thirds below the surface of the earth. Over this, when filled, is placed a dome-shaped cover, sufficiently high above the sand and tile which covers the carbon to allow of a free passage of the flames, and which is continued by flues back through the sides and also underneath, thus completely enveloping the body of the furnace in flames. The carbons are carefully placed in the furnace and separated from each other with washed sand, which is brought from the shores of Lake Ontario. Some days are required to completely load a furnace, as each section will hold about 75,000 carbons.

The cover having been placed in position and sealed with fireclay, the fire is now started, crude oil being the fuel used, as well as in the case of the retorts and moulders' oven. This fire is continued moderately for 48 hours to allow of the gas escaping without blistering the carbon; it is then forced to its utmost for from 48 to 60 hours longer, then shut off, and the whole allowed to cool for 48 hours before uncovering. The top, which is mounted on wheels, is then rolled off and a few carbons taken from various parts of the furnace and tested by a Wheatstone bridge and galvanometer for resistance, as this at once determines if the baking has been carried sufficiently far. If the measurements of all the samples exceed four-tenths of an ohm the furnace is recovered and fired for some hours longer, but this very rarely has to be done. The writer recently tested samples from the north and south ends and centre of a furnace, and they measured 23, 22, and 24 one hundredths of an ohm respectively. Some difficulty was at first experienced in attaching carbons to the bridge, for the resistance of this substance varies considerably with the pressure of contact, and the same carbon measured at different times would often vary several one hundredths of an ohm. But an instrument was designed by the writer which obviated to a great extent, if not wholly, this trouble. The pressure brought to bear on the sample undergoing test by this instrument is determined by small weights suspended from levers attached to holders so arranged that exactly the same pressure and contact is formed on different samples of the same size. If the resistance of the samples, as before mentioned, shows that the contents of the furnace have been sufficiently baked, it is unloaded, the hot carbon being handled with forks.

When cold they are sorted, the first and seconds being easily determined by rolling on level steel plates. After this inspection they are ready for the plating-room, where they receive their copper coat by being hung in leaden vats containing a saturated solution of sulphate of copper. These vats, of which there are several dozen, are connected in series with a 20-ampere constant-current dynamo. Twenty minutes to half an hour is the time required to complete this plating process. They are then washed in hot and cold water and placed on racks to dry, after which they go to the packing department to be rolled in paper and boxed for shipment.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.*

BY PROF. GEORGE FORBES.

LECTURE II.

(Concluded from page 315.)

We must consider the fact that, in working this way, we are conveying our power from our central station to the sub-stations by means of high-pressure electricity; and we are committing ourselves to the statement that high-pressure electricity is the most economical means by which we can transmit power from one place to another. There are several ways in which we can carry power from a central station to different parts of a town. We can do it by passing air compressed at a central station through pipes to the different sub-stations, there using it in engines, which may be ordinary steam engines, to drive our dynamos. Or, we may do it by means of water which is kept under pressure by pumping it into hydraulic accumulators at a central station. From this central station the high-pressure water may similarly be led through mains in the town, and be utilised in water motors for driving the electrical machinery at the sub-stations. These are two ways, besides the electrical way, in which power may be given to the sub-stations from the central source, and we have to consider which of these three is the most economical. The compressed-air method is being largely used at Birmingham. It is also being used for electric lighting in Paris on the Popp system. I do not say that at the present moment the results have been altogether economical, but I do say that the system of transmitting our power to sub-stations by compressed air deserves far more serious attention than has been generally accorded to it. I have heard people who were in ignorance of the methods which can be used for supplying compressed air, or who have only had experience with very defective apparatus for this purpose, speak of the mere 20 or 30 per cent. efficiency obtainable; this is utterly erroneous. The efficiency you can get is very good indeed, and the difficulty lies not so much in that as in the large space taken up in the streets by the pipes to carry the compressed air. The same remarks apply to water power. High pressure water is now being distributed through London from the large central stations of the Hydraulic Power Company. That water is used chiefly for working lifts or elevators; it may be used for other purposes. Here, also, the economy is good. Here, again, the difficulty is a 6in. main which is being used. The total power which can be supplied through such a size of main at the pressure of 700lb. is something like 100 h.p. So that when we come to transmit large powers, the space which would be occupied by the mains would be too large to allow of the system being really practicable in most cases. There might be cases in outlying towns—in parts of London even—where the roadway is not filled up with pipes, where it might be desirable to introduce compressed air or hydraulic power. But probably these cases are very few; and certainly in busy parts, like the city of London, or the greater number of the streets in London, it would

* Cantor Lectures delivered before the Society of Arts.

be too expensive to proceed in this way. So that, in all probability, the high-pressure electrical system is the best for supplying sub-stations; but I beg electrical engineers not to cast aside, as utterly useless, the other means of supplying power from central stations, which may, in some cases, be useful. There is still another way, and that is by the distribution of gas; either the ordinary illuminating gas, or gas specially prepared for heating purposes. Of the latter kind, the best known is the Dowson gas, which can be produced extremely economically—at about 10d. per 1,000ft. The question is, simply, Is it ever economical to introduce gas engines in sub-stations, instead of generating power by steam engines? I have no hesitation in saying that it is in very many cases economical. Gas engines have increased in use in the last few years; the sizes of gas engines have also been increased. Hitherto gas engines have not been made very large, solely because the purposes for which they have been required have generally been those requiring small amounts of power; and people have been doubtful of their applicability to purposes requiring large power. The largest gas engines indicate 170 b.p. with ordinary gas, or about 160 with Dowson gas. Such gas engines are in use in London, and can be seen at work at any time; there are also 98-h.p. engines working at Portsmouth for generating electricity. neers, and that in designing central stations in future, this plan will not be lost sight of.

I will now conclude with referring shortly to some of the systems adopted for laying conductors underground, and will describe to you an ingenious automatic safety device of Mr. Ferranti's, which is appropriate to this lecture. I need hardly take up time with describing different kinds of cable used. We have cables insulated with vulcanised indiarubber, okonite, various bituminous compounds, and air. Some people have used lead covered cables, while in other cases the conductors are left bare. I pointed out a few years ago some serious defects which had occurred in the lead-covered cables employed in Berlin and Rome, due to faults in the manufacture, and want of care in laying. Great improvements have, however, been made since then. I also described, at the meeting of the British Association in Manchester, in 1887, a system of mains which is exceedingly simple. I use cast-iron pipes, and run bare copper tubes through them. The copper tubes, which are supported on porcelain insulators, Fig. 1, may be first used as the conductors alone, and when the demand increases, bare wires can be drawn through the tubes. In the figure, which is more or less diagrammatic, the method of making a house connection is shown, the tubes being tapped into the side of the pipe, through which

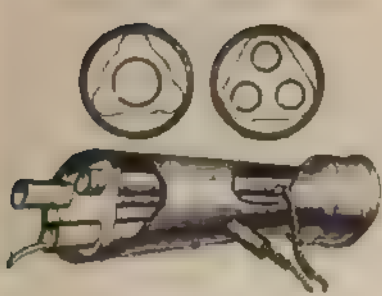

Fig. 1.

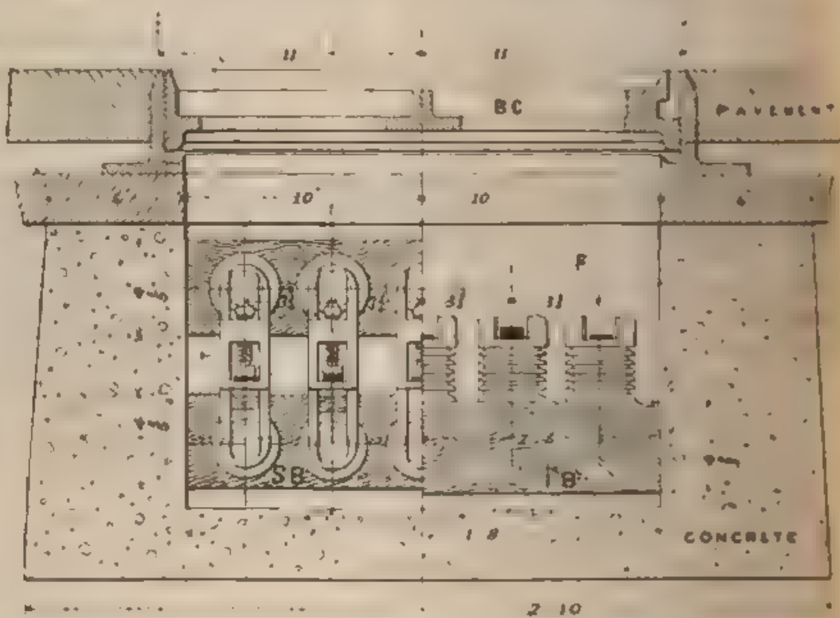

Fig. 2.

The floor space taken up is 14 square feet, therefore the space is not large compared with steam. It would be perfectly easy to make larger ones if they were wanted, but I believe that for such sub-stations as those in which they would be likely to be used, 170 h.p. is as large a size as it would be desirable to introduce, and we should, therefore, be simply using gas engines on the market at the present moment. It is asserted that only 16 cubic feet of gas per horse-power hour indicated is used, and, therefore, even allowing a slight margin for the sanguineness of the manufacturers, we should reduce the cost of power to a very moderate figure, especially in places where gas is very cheap. When we look at this question of using gas engines in its bearing on the load curves I have been speaking of, you will see the enormous gain gas engines could effect. With gas engines, you do not require to be firing up boilers long beforehand for a few hours' work; your gas is always ready, and you can start at the time you have to supply power, without having gone to any waste beforehand in getting your plant into working order, as with steam plant. A large proportion of the 9lb. or 10lb. or 15lb. of coal to the electrical unit needed with steam plant is consumed in heating up the boilers preparatory to starting work; and this means considerable expense, which would not be incurred if gas engines were used. I am sure the question will attract the attention of engi- the house mains are led and soldered to the outside of the copper tubes only, the inner wire conductors being left untouched.

Fig. 2 shows a Crompton conduit formed of concrete, in which bare copper mains rest on glass insulators supported on oak bars. At the extreme left is shown the arrangement by which the copper strips are kept from sagging down between the insulators. The copper strips are passed through the bridge piece, which is insulated from the cross bars by glass insulators also, and when pulled taut are nipped by the set screws, one of which is shown in the sketch, and thereby kept in position.

In Fig 3 is shown a section of the conduit used by the St. James's and Pall Mall Company. This consists of a cast-iron trough with cover, the two being joined by a red-lead joint, and bolted together. Bare copper strips are supported edgeways on porcelain insulators, bridging over the bottom of the conduit to allow of free drainage, and are held in place with wooden wedges. Between the insulators porcelain distance pieces rest on the copper strips to keep them apart, as shown in the figure.

One of the well-known Callender bitumen concrete casings is represented in Fig 4, through which insulated cables are drawn. An objection to this conduit is its perviousness to water. In tests that I have made, a block with four ducts, weighing 20lb. 8oz., absorbed 4oz. of

water during an immersion of 46 hours. Another piece, with two ducts, weighing 6lb. 13oz., absorbed 1oz. in 46 hours, the water being put in the ducts, which were plugged up at one end. In this latter piece a pin-hole was found leading from one of the ducts to the outside, through which the water leaked.

plug which, if allowed to fall, short-circuits the house mains between the points F and G. The primaries and secondaries of the two small transformers are connected up so that the E.M.F.'s of the latter oppose each other, and, being equal in magnitude in the normal state of working, consequently produce no current in the fuse circuit.

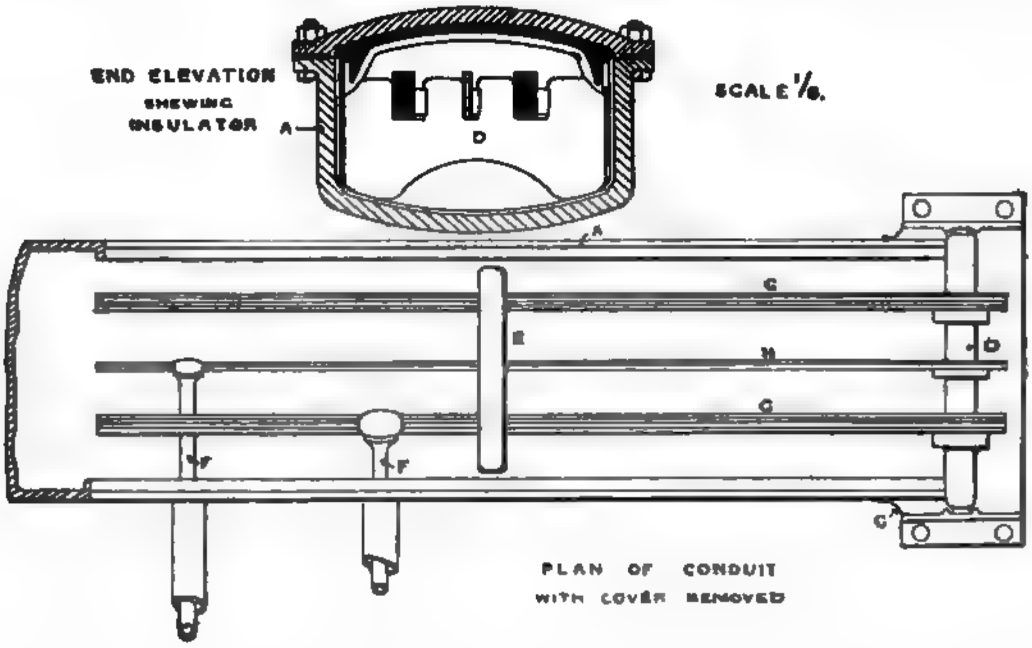

FIG. 3.

Lastly, in Fig. 5, we have the Macdonald conduit. This is made of creosoted wood, and consists of three or more pieces, joined by tongues running the whole length of the conduit. The labour of laying this conduit is small, and the number of ducts can be increased by merely adding centre pieces, the pieces being laid so as to overlap at their ends, as shown, thereby forming a compact whole.

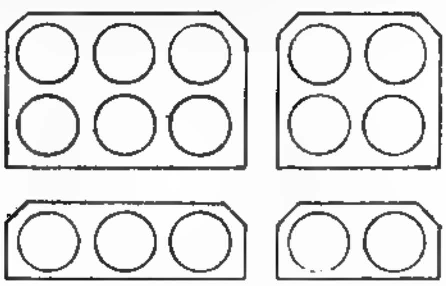

FIG. 4.

The safety device for alternating circuits I mentioned, of which a diagram is shown in Fig. 6, consists in a means for cutting off the supply to a house when there is a leakage on any circuit, or a breakdown of the insulation of

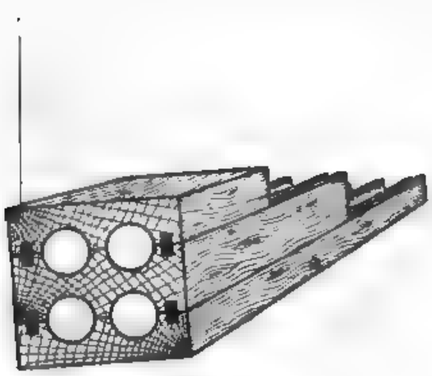

FIG. 5.

the house transformer. A and B are the primary circuits, and C, D the secondary, of two small but similar transformers, the primaries being in series and placed as a shunt across the house mains, the secondaries also being in series but forming part of a distinct circuit, in which is included a fuse, as shown, on which is suspended a

The junction of the primaries is at all times connected to earth. Now suppose a leakage occurs on the lower wire of the lamp circuit. This will upset the balance of the two transformers, by reducing the current passing through A, consequently the E.M.F.'s in the secondary circuits of the transformers will not now be equal, but that in D will overcome that in C, and a current will pass through the fuse and blow it out, allowing the plug to fall and short-circuit the house mains, the result being that the main fuse (not shown) will be blown out and the supply to the house be cut off. The same thing will result if the

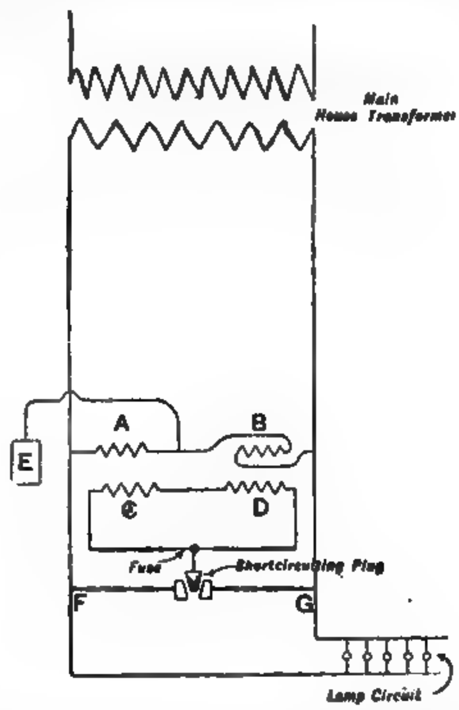

FIG. 6.

pressure rises at either terminal of the secondary of the main transformer, owing, say, to a leakage from the primary to the secondary. In the actual apparatus there is a third block, connected to earth, that the short-circuiting plug makes contact with when it falls, thereby putting the house circuits to earth effectually, and minimising all risk from shocks.

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BOUND VOLUMES.

Vols. I. to VIII. inclusive, new series, of "THE ELECTRICAL ENGINEER" *are now ready, and can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.*

FLASHING.

Unless we are in error, the method of "flashing" so extensively used in the preparation of incandescent lamp filaments will become public property during this November. It was in November, 1878, that Cheesbrough took out the patent for Sawyer. This was the patent round which no infringers could get. Many attempts were made to prepare suitable filaments without flashing, but it may be taken for granted that all such attempts failed. The existing incandescent electric lamp is due to a triumvirate—Sawyer, Edison, Swan. If we were sure no offence would be taken where none is intended, we should define each of these men's work — but such definitions are usually taken in bad part; however, in our opinion Swan provided the filament, Sawyer provided the perfecting part, and Edison supplied the renown required for commercial success. Lane Fox in a measure was before either Edison or Swan, but with every desire to see something in Lane Fox's patent of 1878, we are perforce compelled to acknowledge being so dense and blind as to find absolutely nothing in the shape of an incandescent lamp that had not been suggested before. Hence we cannot include this name in the list of pioneers. Taking the original specification—not amended, because the amending shows information subsequently acquired—the patentee produces a light by passing "the electric current through a thin strip or wire of some suitable material, for which purpose" he prefers "to use an alloy of platinum or iridium." In order to prevent deterioration, he sometimes surrounds "it with an atmosphere of nitrogen gas." There is no claim made for an incandescent lamp in this specification, so we think—especially as there is a specific renunciation of any such claim in the amended specification—that Mr. Lane Fox cannot be described as a pioneer, nor classed with the triumvirate we have named. The history of the modern lamp begins with the work of Sawyer, Edison, and Swan. Up to that time incandescent lamps had been suggested and made, but not with a filament of carbon as we know a filament now. The carbon was cut down and turned to the required size from large pieces, not made as a filament. Retort carbon was most often used, and suggested to be used, but this was outside a filament. Swan's work on carbonised paper, cotton, etc., on parchmentised material, furnished the germ of the filament, and we make bold to say that without Sawyer's flashing process the filament would not be so good to-day as it is. Edison's paper to the American Association for the Advancement of Science in September, 1879, showed his experimental position at that time, but in his results he was probably indebted to Sawyer, who in 1878 took out a patent to expel gas from a filament by heating it when in a globe containing a carbon preservative, and continuing the process of forcing a fresh carbon preservative atmosphere into the globe till the filament was freed from all gas. It was in 1879—or a year after Sawyer—that Edison took out a patent for a somewhat similar process to the above. He heated the filament in a globe from which the

air had been exhausted, and continued the process of exhaustion till the filament was freed from all gas. In 1879, also, Edison took out a patent for a mould for carbonising a whole material; while in 1880 Swan has two patents — one for baking filaments in powdered charcoal or carbon, the other for the parchmentising of material for filaments. We cannot see where this parchmentising process differs from that of Gaine thirty years before—a process fully described in various publications, and applied to paper and vegetable fibres. The application of parchmentised material to the use of incandescent lamp making was Swan's, and we think all the credit of this is due to Mr. Swan. Edison, as is well known, was indefatigable in trying everything he could lay his hands on, and ultimately preferred bamboo. However, we are entering more into history than we at first intended. Sawyer's, or Cheesbrough's, "flashing" patent is numbered 4,847 of 1878—hence the patent lapses this year, and, as above stated, in November. Many people fancy that they have discovered some kind of filament outside the patents of Edison-Swan, and that with the end of the Sawyer patent process they will be able to start manufacture. In our opinion, there can be no real competition with the Edison-Swan combination till the lapse of patent No. 250 of 1880—that is, till the beginning of the year 1894—say, about eighteen months from this date.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SPEED OF ELECTRIC LAUNCHES.

SIR,—On this subject you published some remarks by Mr. Magnus Volk, in your impression for the 16th inst., commenting on some of the claims made with regard to speed of electric launches, based, apparently, on the assumption that the power required for higher speeds is greater in proportion to the square of the increase. If this has been assumed, it is another illustration of the inadequate estimates which have been made of the power required from electric motors to do different kinds of work. Every ship has its own speed and power coefficient, but neglecting this variation between the performance of different vessels, or with any vessel at greatly different speeds, the power required increases as the cube of the speed. Mr. Volk's doubts are therefore well founded.—Yours, etc.,

London, Sept. 23, 1892. W. WORBY BEAUMONT.

ELECTRIC TRACTION IN PARIS.

As already mentioned in our last issue, the Northern Tramway Company in Paris is about to make a bold experiment with accumulator cars in that city, and it may therefore be interesting if a few details are given concerning the proposed tests. When the necessary permission has been obtained, two lines are to be worked. Commencing at the Place de la Madeleine, the first line will end at Saint-Denis (Place aux Gueldres), a distance just exceeding five miles. The second line, which will be nearly six miles long, will start in Paris at Rue Taitbout, and will terminate at the Patte d'Oie, at the other end of Saint-Denis. The profile of each tramway, says the *Bulletin International de l'Eléctricité*, from which we glean the following, is very uneven. There are inclines of as much as 36 millimetres per metre (say 1½in. in 40in.), whilst declines of from 20 to 25 millimetres (say ¾in. to 1in.) are numerous. It is interesting to consider in the following the work to be obtained on these lines with a car of a supposed weight of 12 tons:

OUTWARD JOURNEY.—*In Paris.*

Total maximum effort	433	kilogrametres.
" " " per ton	36	"
Maximum power	12¼	horse-power.
Average power	5·24	"
Average speed	6¾	miles an hour.

Outside Paris.

Total maximum effort	282	kilogrametres.
" " " per ton	23·50	"
Maximum power	16·71	horse-power.
Average power	2·75	"
Average speed	10	miles an hour.

COMPLETE JOURNEY FROM PARIS TO SAINT-DENIS.

Total average effort	83 37	kilogrametres.
" " " per ton	6·95	"
Average power	4·10	horse-power.
Speed per hour	8¾	miles.

RETURN JOURNEY.—*Outside Paris.*

Total maximum effort	324	kilogrametres.
" " " per ton	27.7	"
Maximum power	19·2	horse-power.
Average power	4·92	"
Average speed	10	miles.

In Paris.

Total maximum effort	332	kilogrametres.
" " " per ton	27·7	"
Maximum power	14·6	horse-power.
Average power	4·51	"
Average speed	7½	miles.

COMPLETE RETURN JOURNEY.

Total average effort	91·39	kilogrametres.
" " " per ton	7·61	"
Average power	4·51	horse-power.
Average speed	8 63	miles.

It will be seen from the above figures how varied are the powers required, independent of atmospheric conditions.

It is proposed to place 16 cars in service on the two lines, the cars being of the ordinary type and accommodating 52 passengers. The body of each car is mounted on two independent axles arranged on distinct rectangular frames. Each axle is fitted with a motor of the Manchester type, giving 10,000 watts (about 13½ e.h.p.) when running at 1,200 revolutions. The E.M.F. varies according to the speed, the maximum being 200 volts. The reduction in the speed is effected in the proportion of 10 to 1 by means of two pairs of wheel gearing, and the efficiency guaranteed between the motor axle and the terminals of the dynamo is 70 per cent. The speed of the motor, and, therefore, that of the car, is regulated by a switch having three handles. One of these allows of a change from high to low speed, the reverse operation only being possible by the aid of a key, which is not in the possession of the driver, but is kept at the barrier by an employé, who alone can perform the operation. The object of the second lever is to short-circuit one motor at low speed, if owing to an accident the use of one of the two must be discontinued. The third lever controls the direction of rotation by the reversal of the current. Each car is fitted with a Chalou brake.

The accumulators, which are contained in six boxes, are arranged under the longitudinal seats inside the car. They comprise 108 Laurent-Cèly cells, each having 12 plates and about 37½lb. of active material, and presenting a side surface of 8in. by 6 millimetres (¼in.) thick. The boxes are closed by indiarubber plates which prevent spilling of the solution through the jolting of the car. The daily journey of a horse car in Paris is 62 miles, but by the employment of storage battery cars it is expected that 80·6 miles will be covered by each car, thus requiring five tons of cells. Each car will carry 2½ tons of accumulators, and as the half day's work is about accomplished, the car will return to the depot for a freshly-charged set. The cells are made by the Société pour le Travail Electrique des Metaux at Saint-Denis, where they will be charged and transported to the cars on small Decauville waggons having movable platforms. The charging station will contain four steam engines with horizontal cylinders and Corliss gear, of 125 h.p. each, and running at from 70 to 160 revolutions; these will drive Desroziers dynamos of 60 kilowatts. This experiment is due to the enterprise of M. Broca, manager of the Northern Tramways Company.

THE LIVERPOOL OVERHEAD RAILWAY.*

BY JAMES HENRY GREATHEAD, M.I.C.E.

The question of improved and more rapid means of transit for passengers is occupying attention in many of the great cities at the present time. With the extension of areas covered the question become increasingly pressing.

In London it has been under consideration for many years, and during the last session a joint committee of the two Houses of Parliament reported favourably upon a number of proposed underground electric railways of the type of the City and South London Railway, completed and opened for traffic in 1890.

In Paris, Berlin, and Vienna, similar railways have been promoted and are under discussion; while in New York, a city long since provided with elevated railways and tramways along most of the main thoroughfares, a Rapid Transit Commission has lately reported in favour of an extensive system of underground electric railways, and in other American cities, notwithstanding the rapid development of electrically worked tramways, additional facilities in the shape of over and underground lines are being considered.

This question, then, is an important one for engineers and the iron industries.

All the proposed underground lines are, since the construction of the City and South London Railway, proposed to be made of iron, and that material must necessarily enter largely into the construction of any overhead railway.

The particular railway under discussion is composed almost entirely of wrought iron. The line, now approaching completion, traverses the whole length of the famous Liverpool Docks, a distance of about six miles (as will be seen by reference to the plan upon the wall). The extensions north and south, authorised last session, are also shown, and it will be seen that they go beyond the docks and away from the river in order to give better access between the residential neighbourhood reached by them, the docks, and the heart of the city.

With the exception of a short length where the line passes under the Lancashire and Yorkshire Railway coal sidings, the railway is, as it name indicates, overhead, and for the most part just over the lines of the original Dock Railway, which is upon the surface. The latter railway serves for the distribution of goods by horse traction, and has been used also by passenger omnibuses, with specially constructed wheels to enable them to leave the track when necessary. They will leave the rails altogether upon the completion of the overhead railway, which will afford a means of transit at least three times as rapid, when the Dock Railway will be available exclusively for goods.

The overhead railway consists generally of plate-iron girders supported upon channel-iron columns, and carrying an iron flooring, upon which the permanent way is laid direct, without the usual intervening ballast. The normal spans are 50ft., but there are some of 100ft., with bowstring girders, and others of special construction for opening and affording a passage to the docks for exceptionally bulky goods, such as marine boilers, etc., thus there is a tilting bridge near the Sandown Dock, and a swing bridge of novel construction, and worked hydraulically, crossing the entrance to the Stanley Dock. This is the only dock entrance crossed by the railway, the other docks being on the river side of it.

The columns are grouted into cast iron sockets, bedded in and bolted to masses of concrete, forming the foundation.

With the exception of some half-dozen spans, the line has been constructed without the use of scaffolding, and with very little interference with the traffic, either of the docks or of the streets.

This important end was attained by adopting a construction which admitted of each span and its flooring being put together at one end, and transported as a whole over the already completed portion of the railway.

A depôt was established at the north end of the railway, where the flooring was constructed and riveted together and to the main girders. The whole span was then raised by jacks, a steam bogey with wheels running upon the two rails nearest the main girders (and thus having a gauge of 16ft.), was run under the span, which, being lowered upon the trolley, was carried by it at such a level as to clear the main girders to the southern end of the structure. Arrived at this point, the span was slung upon a movable gantry, and by it deposited upon the columns prepared to receive it. In this manner span after span was added, as many as 10 being placed in a week, representing a length of 500ft. of railway.

Photographs illustrating the operations of construction and portions of the railway accompany the paper, and the details of construction of one of the normal spans are shown in the accompanying drawings, and do not therefore require description.

The decking is of arched plates, finishing to 2ft. 6in. wide and 15in. deep, made watertight by asphalte placed in the V channel between the arches; this form of flooring (known as Hobson's arch plate system), first used on this railway, is being extensively used elsewhere. It is for its weight of great strength and stiffness, and is readily made watertight.

The flooring is made of ordinary iron plates and tees. The plates are 46in. wide by $\frac{5}{16}$in. thick, and vary in length from 22ft. to 27ft. The tees are 4½in. by 3½in. by $\frac{7}{16}$in. section, and are of lengths corresponding to the plates. A cross-section is as shown in Fig. 1.

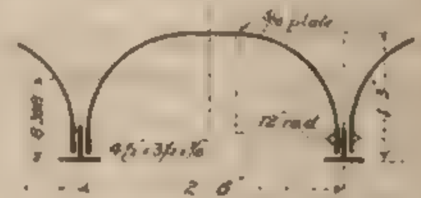


FIG. 1.

In order to ascertain the exact strength of the floor, some actual sections were tested to destruction, and the deflections at each increase of load were carefully tabulated with the following results.

Test.—*a.* Three sections of floor measuring 7ft. 6in. in width.

b. Span, 22ft., ends resting upon supports.

c. Load distributed over four points corresponding with the positions of the rails.

Test load.	Deflection at centre.
30 tons	nil
35 „	⅜ inch
40 „	½ „
50 „	$\frac{11}{16}$ „
60 „	¾ „
70 „	1⅛ „
80 „	1¼ „
90 „	1½ „
100 „	1$\frac{11}{16}$ „
110 „	2 „ (limit)

The floor plates ultimately collapsed by the total rupture of the T irons at 160 tons, and with a deflection of 10in.

It is hoped that members may be able to see the actual construction of the decking at the north end. A short description may, therefore, be of interest. The flat plates are delivered sheared to exact length and width. Six of them at a time are heated in a long oven (to a cherry-red heat), whence they are separately hauled out endways into a hydraulic press, which bends them to the required shape. After cooling upon a grid or frame, where they are tightly held to prevent change of form, they are taken to a multiple drilling machine, which drills the requisite rivet-holes (about 200) in two operations and in 15 minutes. After the end angle irons, for attachment to the main girders, are added, the decking is completed by riveting mechanically the covered plates to the T irons forming the lower member. These combined operations are performed at the rate of 40 to 45 plates per day.

There are to be 15 stations. They are built upon iron girders and columns, the platforms being about 115ft. in length by 12ft. wide, and are 3ft. above rail level. Access to the platform is gained from the street level by four staircases at the more important stations, and on each platform a waiting shed is provided with pay offices and turnstiles. An extensive carriage shed is erected near the Hornby Docks, with five lines of way running through at the same rail level as the main structure of the railway

* Paper read before a meeting of the Iron and Steel Institute.

and underneath, on the ground floor is the repairing shop, to be equipped with the necessary tools. The railway is to be worked by electricity, generated at a station, for which 12 of the arches, forming the viaduct which carries the coal sidings of the Lancashire and Yorkshire Railway, have been appropriated, near the Bramley Moore Dock, and about the middle of the line. At this station are three engines, each capable of working up to 400 i.h.p., and each driving a separate Elwell Parker dynamo. The electricity will be carried north and south along the railway by a steel conductor, placed on porcelain insulators, supported upon cross timbers between the rails of each line.

Hinged collectors of cast iron, sliding upon this conductor, will make the connection between the motors upon the train and the dynamos at the generating station. The motors are not placed (as on the City and South London Railway) upon a separate locomotive, but are carried by the passenger carriages themselves.

A train will consist of two carriages, each to seat 56 passengers, and provided with a motor at one end. The carriages will be so coupled as to give a motor at each end of the train, and the motors will be so connected together as to be controlled from either end by the driver, who will always travel at the front end, changing ends upon arrival at a terminus, and carrying with him a key, without which the motors cannot be operated.

All the carriages will be exactly alike, and will contain compartments for two classes of passengers, with through communication from end to end of the train under the control of the guard. A train loaded with passengers will weigh about 40 tons. The trains will be lighted by electricity, and are fitted with the Westinghouse brake, deriving its compressed air from a reservoir on the train, the reservoir being charged after each journey. This system of working the brakes has been found to answer well on the City and South London Railway. The generating station will contain at first six boilers of the Lancashire type, each 30ft. long by 8ft. diameter, with a working pressure of 120lb., and stoked mechanically. The engines are horizontal, compound condensing, by Messrs. John Musgrave and Sons, Bolton. It is intended to commence running with a five-minutes' service of trains, but the generating plant is designed to be capable of working a three-minutes' service, and the journey from end to end of the railway (inclusive of stoppages) is to be performed in half-an-hour. There are 13 stations upon the dock portion of the line, and a novel feature on the railway will be a system (Timmis's) of automatic signals at all the intermediate stations, in place of the ordinary signalling arrangements. These signals will be electrically worked by the trains themselves, and considerable saving in the working expenses will result.

The permanent way, it will also be noticed, is of a novel construction. Longitudinal sleepers, resting directly upon and keyed to the arched decking, support the rails and the electric conductor. As already stated, there is no ballast between the permanent way and the structure, and the working charges in connection with the maintenance and repair of the permanent way should be exceptionally light.

The total cost of the railway, including equipment, will be about £85,000 per mile. Mr. J. W. Willans is the contractor for the works, and the Electric Construction Corporation, Limited (Wolverhampton), are providing the electrical equipment and the carriages. The engineers, Sir Douglas Fox and the author, have been represented on the work by Mr. Francis Fox and Mr. S. B. Cottrell, and Mr. F. Hudleston has had charge of the work (for Mr. Willans), and to him is due the credit for the design of the tilting and swing bridges referred to. It is intended to open the line for traffic very shortly.

Ore Recorder.—Electricity does not confine its usefulness to lighting and hauling for mines, and an additional application has been found in an electric recorder for registering the output of ore which has been installed on the pithead of a Belgian lead mine. Each load of ore delivered at the top of the shaft completes a connection to an electromagnetic mechanism, and marks a red line on a sheet of paper moved by a revolving barrel in the ordinary manner of registering instruments.

THE ELIESON NEW ACCUMULATOR.

In the accompanying drawing we illustrate a new form of accumulator invented by Mr. C. P. Elieson. This accumulator is entirely on the Planté principle, and it will easily be perceived that although it is only composed of two electrodes, a large amount of surface is nevertheless provided for the storage of electrical energy. Figs. 1, 2, and 3 are the three parts composing such an element, Fig. 1 being the negative electrode, Fig. 2 the separator, and Fig. 3

FIG. 1. FIG. 2. FIG. 3.

the positive electrode. The positive electrode is inserted in the skeleton box, Fig. 2, the whole is then placed into the negative electrode. A hard rubber box is provided with a rim extending 1in. from the bottom of the box, upon which rim the negative electrode rests so as to prevent any possible short-circuiting from the agglomeration of

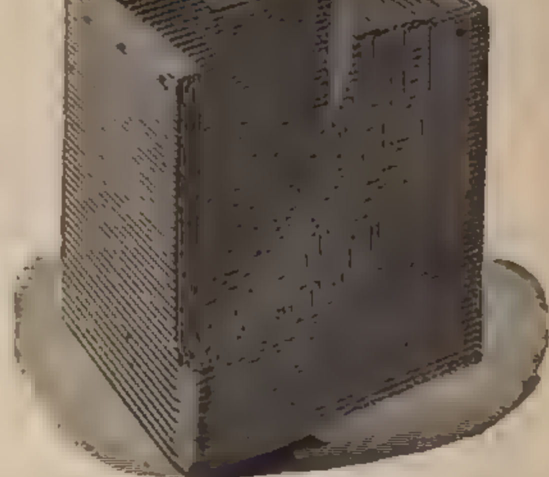


FIG. 4.

oxide dropping at the bottom. Fig. 4 gives a view of one electrode, where a portion is removed in order to show the internal construction, which is built up of a series of corrugated and perforated envelopes of thin lead. Each of these envelopes are built up on top of each other, and each corrugation is so arranged as to run across or at an angle with the corrugation of the next envelope; in practice, nine of such envelopes compose one electrode.

The positive electrode, 5in. by 3¾in. by 8in., possesses 4,000 square inches of exposed surface, the negative electrode measures 6½in. by 4½in. by 8in. in. The lugs which are on each electrode run right to the bottom, and are burnt through and through in order to secure a perfect metallic connection with each envelope. The weight of the two electrodes is 12½lb., or 23lb. including box and electrolyte. It is claimed that such an accumulator requires very little attention, and that the positive electrode will hardly require renewing after 12 months' hard work. The formation process is carried out in the usual way, partly chemically and finished off electrically. The storage capacity of this cell is about 100 ampere hours, but the formation can be stopped at 60 or 80 ampere hours, as it will soon increase in its capacity while in actual work.

THE PROBLEMS OF COMMERCIAL ELECTROLYSIS.*

BY J. SWINBURNE, MEMBER.

It would be idle to attempt to go over the whole subject of the technical applications of electrolysis, as, although this development of industry is of very recent growth, it is already so extensive that many of its branches demand evenings devoted exclusively to their discussion. My object is, however, to take a sort of birdseye view of the subject, and, if possible, to try to foresee the directions in which others must seek for future developments.

There is a very general feeling that there is a mine of untold wealth in the application of electricity to metallurgy, but chemists are not generally electricians, and electricians are seldom chemists. It seemed, therefore, advisable to bring the paper before this Institution, in the hope that it will result in a discussion, and if it leads to the expression of the views both of electrical engineers and manufacturing chemists, and to a further approach to common ground, our time will be well spent.

However puzzling the theory of electrolysis may be, for commercial purposes it may be regarded as involving no mystery. In fact, broadly speaking, we may disregard the electrical side of the question and look upon electrolysis as a method of oxidising and reducing, and nothing more. It must be remembered, however, that there often many ways of oxidising the same substance. For instance, a sulphide may be oxidised into a sulphite or sulphate, or sulphur may be liberated. Electrolysis does not always afford the means of oxidising in the particular manner desired. A very large number of the processes employed in chemical industry consist merely in oxidising and reducing, special conditions being arranged to suit the particular substance being operated upon. Once we take this broad view, all we have to consider is, "Which of the oxidising and reducing processes in use in chemical works can we advantageously replace by electrical methods?" In many cases electrical methods are impossible; in others they are more expensive than those at present in use; but it is hardly too much to say that in an enormous number electrolysis is destined to play a leading part in the near future.

Take, for instance, the case of reduction. This is almost universally effected by means of hot carbon, and at first sight it seems unlikely that it could pay to burn the carbon under a boiler, and get a small percentage of the energy back in the electrical form, and to utilise that portion alone. It must be remembered, however, that the methods of reduction by burning carbon are themselves exceedingly inefficient, and, moreover, they very often give impure products. By means of electrolysis, however, it is frequently possible to secure metals of the highest purity by direct processes. Before going further, it will be wise to form some idea of the cost of electrical energy in, say, a large chemical works. Of course "cost" is a loose term: we might calculate it from the cost of coal and labour and sundries; or we might add interest and depreciation, rent and superintendence. In all cases in estimating the cost, further additions have to be made for standing charges, advertising, profits, maintaining patents, etc. It is unnecessary to trouble ourselves about definitions of cost, for if it is stated how the figures are obtained, the selling price can be worked out and comparisons can be made.

Suppose a plant is put up to give a million watts, it will be found that if the plant is taken as running day and night, including Sundays, and if the best engines, with modern dynamos, are employed, the cost comes out about 0·25d. per kilowatt hour. This figure includes interest, and depreciation of engines, boilers, and buildings, and coal, labour, and petty stores; but does not include rent or salaried superintendence. This figure will appear ridiculous to those accustomed to London central stations; but that is because central stations work under the most disadvantageous conditions possible, while a chemical works has everything in its favour.

OXIDATION AND REDUCTION.

Oxygen.—The first obvious application of electrolysis is the decomposition of water. In an acid solution platinum or lead anodes are necessary; platinum is expensive, and lead takes a high E.M.F., so it would be best to use an alkaline solution with iron electrodes. Allowing two volts as the pressure required, the cost comes out at 5s. 7d. per 1,000ft. for the oxygen. The hydrogen is taken as valueless. As the output in oxygen must be small, we must take a much higher figure than the ¼d. per kilowatt-hour; in fact, it would be safer to double the price and say 11s. 2d. To find the selling price we must allow for packing in cylinders, and add all the trade charges, which will probably bring the price up to something like 15s. per 1,000 cubic feet. The retail price of Brin's oxygen is 2d. per cubic foot, so there would appear to be a very large margin.

Alkali.—We come next to a subject which has already absorbed an enormous amount of labour and thought, and that is, the production of caustic soda and chlorine from common salt. The Leblanc and Weldon process is exceedingly complicated and very costly, and as by simply electrolysing salt, costing about 15s. a ton, chlorine and caustic soda can be produced, it seems, at first sight, at least, most strange that electrolytic processes have not replaced all others within the last few years. Assuming that the process works, let us first form a rough idea of its probable economy. With suitable vats, and a reasonable current density, we may take it that three volts is a liberal allowance. For the ton of 75 per cent. caustic soda, we have electrical energy, £2 15s.; salt, £1 2s. 6d.; lime, £1 3s.; total, £5 0s. 6d. For £5 we have thus obtained a ton of caustic and 1½ tons of bleaching powder. We have allowed nothing for the cost of vats, for labour at the vats and in handling, or for evaporation of causticised liquor. The ordinary caustic liquor after causticising is quite weak, but electrolytic caustic can be made into a strong lye. On a small scale I have produced lye with 30 per cent. caustic. To do this the brine is electrolysed and then stirred up with more salt, and so on; the process being repeated several times. Strong caustic is a good conductor, so this method is good from that point of view as well as from that of saving in evaporation. Evaporation with a Yaryan should not come to more than a shilling or two a ton extra. It would doubtless be safe to say that, taking this way of estimating the cost, a ton of caustic and a ton and a half of bleach should be made for £6. This allows an enormous margin for expenses and for profits. This method of estimating is very rough; and unless a new process worked out in this sort of way comes out with an enormous margin, it is not likely to be worthy of serious consideration. On looking into it further, it will generally be found that when all the details of expenditure which will be necessary in practice are added, the margin, if it still exists, is too small. In fact, a new process must look marvellously good on paper to be really worth anything when tried commercially. Electrolytic soda and bleach seems to have an excessive margin, however, and we have to see whether there is any other weak point.

I believe the difficulty, and the only difficulty, lies in the anodes. Process after process is brought out, and each claims to have solved the problem of electrolytic soda by the use of some new arrangement of the porous partition, or by some other detail which can hardly make all the difference between success and failure. The various processes make a little excitement for a time, and then disappear, I believe because the anodes are destroyed.

Of course none of the ordinary metals can be used as anodes, as they are attacked at once. Platinum is generally supposed not to be attacked by chlorine, but I find that it is slowly eaten away. I would like to hear this confirmed or denied by others, for it is a very important point. On the one hand I find experimental anodes eaten away; on the other we hear of platinum anodes being used extensively in the electrolysis of chlorides. Of course, in the manufacture of such a cheap commodity as soda, the capital invested in platinum anodes would be prohibitive, and the least waste of metal would lead to ruinous expenditure. The next material to consider is carbon. In 1882 Bartoli and Papasogli pointed out that carbon was attacked when used in any solution which evolves oxygen. Without knowing of their work, I found the same thing by a series of experiments carried out in 1883. In those days it was tacitly assumed that carbon with peroxide of lead could be used in the ordinary secondary batteries, without any fear of local action. Though carbon does not seem to combine with chlorine during electrolysis, I find that it is always attacked, even in a solution of salt. I have tried every kind of carbon I can think of, and the result has always been that the anode was corroded. I do not mean to say that carbon is eaten away at a rate at all corresponding to that with which the soda is formed; in comparison the corrosion is

* Paper read before the Institution of Electrical Engineers.

slow. It must be remembered, however, that a very slow corrosion makes carbon anodes useless when the products are cheap.

Carbon is also troublesome mechanically. It is difficult to make good contacts with it, especially when there is chlorine about. Large carbon plates are also expensive. Mr. Greenwood overcomes this last difficulty by electroplating one side of a number of comparatively small plates, and then soldering them to a plate of type metal. The type metal is not exposed to the solution anywhere, else it would be attacked by the chlorine. By this means he produces a large carbon anode with a good metallic connection.

Peroxide of lead seems to present a solution of the problem. Unfortunately, however, peroxide of lead is reduced by hydrochloric acid, and it seems to be impossible to electrolyse salt without producing some free acid at the anode. Some specimens of lithanode I tried were attacked. I do not know, though, whether the inexhaustible ingenuity of Mr. Fitzgerald has produced any special make which will stand traces of free acid. I am inclined to think, therefore, that progress is barred in this direction solely by the want of a good anode. If this is the case, there is a fortune awaiting the inventor who can find something which will act as an anode in a solution of common salt.

I have tried electrolysing sodium sulphate. There is not the same margin here. You get hydrochloric acid as a by-product instead of chlorine, so that the Weldon process would still be necessary; and the sulphuric acid would have to be concentrated every cycle, in order to act on the next batch of salt. This process would, in fact, save the black ash part of the soda process, and, like all these methods, would demand carbonic acid to make soda crystals. Of course this last is not a serious difficulty, especially if quicklime is needed to absorb the chlorine. In this case I tried lead anodes, when, to my surprise, the small traces of chloride left in the sulphate corroded the lead anodes.

Paper makers use large quantities both of caustic and bleach, and they recover soda and causticise it on their works. It would therefore be an enormous advantage to be able to produce caustic and bleach direct on their own premises. I do not know if the presence of salt would interfere in any way with the action of caustic in the grass or straw boilers, but should think not. By making the caustic on the spot, a saving is effected in the processes otherwise necessary. There would be no need to concentrate the lye, or to fish out the salt that may be present. Caustic drums and carriage would be saved; but, of course, against this there may be carriage of salt. The importance to paper works is so great that it is almost a question whether it would not pay to face the corrosion of the carbons, and to arrange vats so that the anodes can be easily replaced.

In the Hermite process the chlorine is not given off, but a hypochlorite is formed. Of course, in this case caustic soda cannot be made. For paper works especially it is obviously cheaper to supply lime and get bleaching powder and caustic, than to make sodium hypochlorite only. This may, however, depend on the anodes. Platinum anodes are used in this process, and it seems to be the case that platinum is not attacked in an alkaline chloride. If this is so, it is possible to produce hypochlorite of soda, but not caustic and bleaching powder. The Hermite process is apparently commercially successful. Magnesium chloride is generally employed in the Hermite process, but I have been told that salt is now used. It has been said that electrolytic hypochlorites, especially of magnesium, have more bleaching power than the ordinary bleaching powder. Of course a sodium, or any other hypochlorite, may be formed which has twice as much of its chlorine available, when compared with bleaching powder; but this is merely an apparent gain, as it takes twice as much electricity to produce the hypochlorite. Messrs. Cross and Bevan, however, hold that the bleaching power of these compounds is not as determined by arsenious acid. They maintain that the fibres to be bleached contain some ketones or other, and these ketones absorb some of the available chlorine, especially when provided by bleaching powder; that the hypochlorite of sodium and of calcium waste available chlorine on the useless work of chlorinating these ketones, while magnesium hypochlorite devotes its whole attention to honest bleaching. Of course if it is slightly easier to oxidise the colouring matters than to attack the ketones, it may be the case that a hypochlorite of a weak base, like magnesium, may be able to bleach, but not to attack ketones. It would then be better than the hypochlorite of calcium, or especially sodium. These matters are better left in the hands of such authorities as Messrs. Cross and Bevan. They make out, also, that electrolytically prepared magnesium hypochlorite is best. This seems very strange. Of course it would mean that some other salt is really formed. The properties of a salt cannot depend on the method of its preparation, and there is no magic in electrolysis.

Potassium Chlorate.—The manufacture of potassium chlorate is carried out by electrolysing a hot solution of the chloride. The chlorate is then formed instead of the hypochlorite. This process is carried out on a large scale at Vallorbes, in France, under the direction of M. Gall de Montlaur. It is stated that they make a ton a day, 24 horse-power hours yielding 2·2lb. The power is supplied by a waterfall, so that the chlorate should be very cheaply made, if the anodes are absolutely free from corrosion. Platinum anodes are employed.

The Electrolysis of Fused Salt.

Many inventors have been at work on electrolysis of fused salt. At first sight this also seems most simple. Salt is cheap, and is fusible, and, therefore, all that has to be done is to melt it and electrolyse it, getting sodium at one pole and chlorine at the other. The sodium could be sold at a very low price for making aluminium, and for amalgamation in gold extraction, and can, of course, be converted into caustic soda or crystals as desired. Consumers of caustic would buy the metallic sodium, and would add water, thus obtaining pure caustic. The margin of profit in this case is apparently enormous.

The difficulties are, however, very serious. In the first place, sodium chloride boils at a very little above its melting point. The result is that the sodium is obtained mixed with large quantities of salt. Melted salt is by no means a convenient substance to handle. It acts on many kinds of clay, so that ordinary fireclay crucibles cannot be employed. Chlorine at a temperature corresponding to a red heat is also troublesome to deal with. It is said that chlorine will not attack a dry metal, so that iron can be used for the containing vessel. Most patentees describe vessels of iron with porcelain where insulation is necessary.

We now come to the anodes again. As there is no oxygen present, it would seem as if carbon might be used. Patentees always mention carbon anodes. Retort carbon is eaten away, and so are electric light or artificial carbon rods.

It seems strange that carbon should be attacked, and it would be well for these experiments to be repeated, to make sure that there is no error. Of course carbon is the only hope. Whether the chlorine is dry or not, metals are eaten away with great rapidity. The anodes are corroded chiefly at the surface. In addition to these troubles, the theoretical quantity of sodium is not obtained. Some people have supposed that there is a subchloride formed, and that sodium is really not a monovalent metal. This is rather an extravagant notion. I do not know why both sodium and chlorine should not be soluble in the fused chloride without forming any definite compound. So many workers have been unsuccessful with fused salt, that it looks as if there were some insuperable obstacle in the way, and it is questionable whether the ground is worth any further labour.

Electrolysis of Fused Soda.

Castner has recently proposed to produce sodium cheaply by the electrolysis of fused caustic. The temperature is to be high enough to fuse the caustic, but not high enough for the sodium to decompose the fused hydrate forming oxide. Whether this process has had any success commercially, I do not know.

Aluminium.

The extraction of aluminium has long been an important problem. The old method was to replace aluminium in its chloride by means of sodium. This involves the manufacture of metallic sodium, and of the anhydrous chloride of aluminium. The anhydrous chloride cannot be obtained by evaporation of its solution, as the solution gives off hydrochloric acid and leaves alumina; otherwise the anhydrous chloride would be quite cheap. The price of sodium has been reduced recently by the Castner process, but the extraction of aluminium by ordinary means is still so expensive that electrical methods can compete.

It seems to be impossible to deposit aluminium from any of its solutions, so fused salts have to be employed. The electrolytic processes differ in detail only. The electrolyte is cryolite, or a solution of alumina in cryolite. If cryolite is electrolysed, aluminium is deposited, and fluorine is presumably evolved at the anode, which is made of carbon. I have not seen any account of how the fluorine comes off. Yet in some processes it is stated that cryolite is electrolysed by itself. In the Minet process the solution of oxide is employed, and aluminium is deposited, and the anodes are burned away by the oxygen, giving off, according to some accounts, carbon dioxide, but probably the monoxide in fact. The chief difficulties in the electrolysis of cryolite solutions are due to the cryolite itself, as it attacks all the substances commonly employed for making crucibles. It is therefore usual to use cast iron to make the containing vessels or vats, and to heat the electrolyte by electrical power from the inside.

Minet uses iron vats, and arranges a shunt-current, which makes the vats to some extent cathodes, so that they are not attacked by the electrolyte. Presumably, fluorine is soluble in fused cryolite, and attacks iron. By making it a cathode it is always coated with aluminium, so that any fluorine is taken up in dissolving off some of this aluminium. The importance of preventing the corrosion does not lie so much in the slight saving

of iron as in the avoidance of any deposit of this metal in the aluminium. The great difficulty is to get the aluminium pure, and any trace of iron reduces its value for most purposes very greatly. Minet reduces the melting point of the electrolyte by the addition of common salt. In the Hall process, carried on at Pittsburg, the electrolyte is practically the same. Calcium fluoride is used to mix with the cryolite, or calcium chloride. The Kleiner, and, I believe, the Hall, processes, are carried on in England. The processes have so often been fully described elsewhere, that I need not discuss them at any length here. There is still a great demand for cheaper aluminium; and there is much to be done in making it pure. Aluminium has a strong affinity for silicon, and small percentages of silicon and iron are generally present, and are very deleterious.

MAGNESIUM.

This metal is closely allied to aluminium, and is similar with regard to its anhydrous chloride. There is not the same demand for it, as either it does not give remarkable alloys like those of aluminium, or they have not been investigated. It is said to be made on the Continent by electrolysing the double chloride of magnesium and sodium or potassium obtained from the mother liquid after evaporating sea water. The double salt can apparently be rendered anhydrous without the formation of much magnesia.

ZINC.

Proposals have been made to deal with zinc ores electrically. The blend is to be roasted into sulphate, and the solution dissolved and electrolysed. A great difficulty arises in the deposition of the metal. It comes down in trees. Kiliani proposed to use high current densities, holding that zinc then comes down in the reguline state. Watt prefers to use acetate of zinc as the electrolyte; and alkaline solutions, such as zincate of soda, have also been proposed. I am not aware that zinc has been deposited commercially. Similar processes have been proposed for dealing with the silver zinc alloy produced in the Parkes or Karsten desilverisation process.

LEAD.

So far little has been done in the way of dealing with lead ores electrically. It has been proposed to make anodes of galena, and to work with lead nitrate as electrolyte, but I have not heard that any such process has been carried out successfully. It is hardly likely that it could, as lead forms troublesome trees in acid solutions. Anyone who has worked with solutions of such salts as lead nitrate would be inclined to give up all hope of obtaining anything like a reasonably compact deposit of lead.

The extraction of silver from lead by the Pattinson process is very cumbrous and roundabout, and is, of course, expensive. Keith started a works in America for desilverising electrolytically. He used a solution of sulphate of lead in sodium acetate as electrolyte. Though the Keith process was brought out some 10 ten years ago, it does not seem to have come into general use. The deposit of lead even from such a solution as sodium plumbite is very bulky and spongy, and is difficult to deal with, as it is apt to decompose water and oxidise spontaneously during handling.

GOLD AND SILVER.

Greenwood and others have proposed to make chlorine electrolytically for catching gold by the chlorine process. As this is exactly the same problem as making bleaching powder, the same difficulties have to be overcome; so it need not be discussed further.

Mr. Crookes's sodium amalgam for making the mercury ready to seize any particles of gold, and to keep it from getting "sick," can be replaced by making the mercury itself the cathode. It is questionable whether this would be worth while, as the sodium amalgam is very convenient.

Mr. Crookes has recently brought out other electric gold processes. He finds that the particles of gold become amalgamated, and collect and get caught in the mercury, if the stamped quartz is washed in a weak solution of a mercury salt, under the influence of an alternating current of small frequency. It is difficult to see how the alternating current works. Unless the current density or the resistance of the electrolyte is something fabulous, there cannot be any current in the small particles of gold, as the minutest polarisation would make all the electricity flow by the electrolyte, and not by the little pieces of gold, even though they are very much better conductors.

(To be continued.)

Colliery Explosion. – Every serious colliery explosion is a chance that ought to be taken by business managers of electric lighting apparatus to push the advantages of electricity. The recent Park Slip explosion has been the occasion of remarks in the local papers upon the desirability of introducing portable electric lamps, and a short notice sent round to the papers of the district would be sure of gaining insertion and creating interest. Electricity is destined to provide greater safety and better facilities in colliery work, and the use of every opportunity should be taken to force home this fact.

TRADE NOTES AND NOVELTIES.

HOLDEN, DRAKE, AND GORHAM'S NEW ELECTRICAL RECORDING INSTRUMENTS.

The instruments which are now introduced by Messrs. Drake and Gorham are said to be free from many of the defects of design, which would cause readings in many existing instruments to differ from the indication of standards with which they might be compared. The new series of instruments includes the following: 1. Recording ammeter, hot strip principle for either direct or alternating currents, with continuous record. 2. Recording voltmeter: electromagnetic with moving coil, open reading for direct currents with intermittent record. 3. Recording ammeter, dead beat, electromagnetic for direct currents, with continuous or intermittent records. 4. Recording voltmeter, dead beat, electromagnetic for direct currents, with continuous or intermittent record. 5. Recording

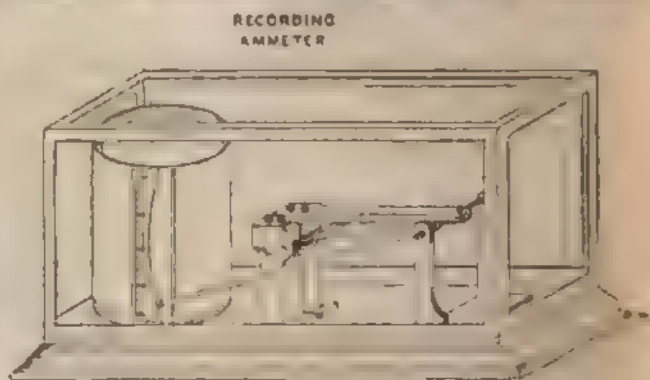


FIG. 1.

ammeter, frictionless, dead beat, with photographic continuous record for direct currents. 6. Recording voltmeter, frictionless, dead beat, with photographic continuous record for direct currents. 7. Combined recording ammeter and voltmeter, dead beat, frictionless, with intermittent photographic record for direct currents. 8. Recording ammeter, frictionless, dead beat, with photographic record for alternating currents. 9. Recording voltmeter, frictionless, dead beat, with photographic record for alternating currents.

The hot strip recording ammeter, for either direct or alternating currents, is illustrated in Fig. 1, and the principle employed in the working portion is clearly shown in the diagram of Fig. 2. Here we have two metal strips, A and B, as shown, of the same length, section, and material. These strips are fastened together by rivets, or otherwise secured at the point E, and also rigidly secured at C and D. If not fastened together at E, they might be supposed to be capable of turning about the points C and D, describing the arc C_1 and D_1 respectively. But the strips are rigidly connected at E, and, therefore, if only the upper strip, A, is caused to extend by a rise of temperature in

FIG. 2.

it, produced by the passage of the current, the position which the system of strips will be forced to take up will be one in which the equilibrium is obtained, and this position will manifestly depend on the actual amount of extension of the top strip. For instance, suppose that the amount of extension of the top strip, A, is equal to the length of the line F G, then the dotted line, C G D, will represent the position of the system when the strip A has extended by that amount; and, moreover, it is obvious that this position will be the only one in which equilibrium is produced by a certain definite current in the strip A. It may, therefore, be said that the position is dependent upon a certain current. It will be understood that a rise of temperature in both strips simultaneously, such as would be produced by atmospheric causes, will not affect the system at all, since each strip will lengthen to the same extent independently, and there will be no turning movement whatever. The record is made on a piece of corrugated paper attached to a vertical drum revolved by clockwork (at a rate which is regulated to suit requirements), by means of a pen containing aniline ink, giving a continuous record. The

pen is attached by an aluminium arm to an arbor, which is turned through a greater or less angle according to the amount of expansion of the strip. A fixed scale close to the pen enables the amount of current passing at any moment to be read by the eye. This instrument is suitable for alternating or direct-current circuits. It has no errors and takes little power; on the other hand, owing to the rigidity of the system of metal strips, it is free from the errors which arise from the friction of the pen upon the paper, and form a source of inaccuracy in most of the recording instruments employed at the present time. The width of the paper strip may be from 3in. to 6in. according to whether a very open scale is required or not.

The feature of the recording voltmeter with moving coil, for direct currents, is its extremely open reading, which combined with its frictionless action, owing to the intermittent record which it is caused to make by means of an accessory electromagnet, renders it extremely valuable for checking small variations of potential. The electrical portion of the apparatus

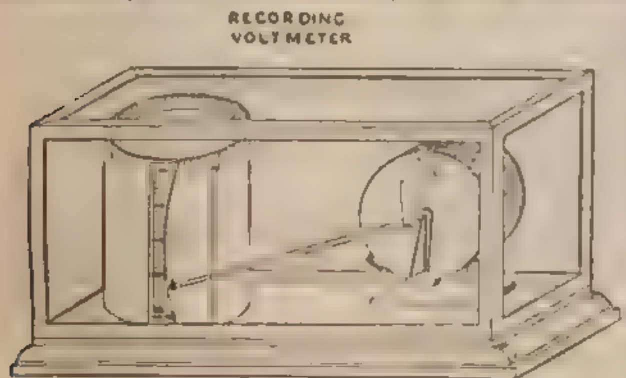


FIG. 3.

consists of a coil, mounted on an arbor working in jewelled mercurial bearings, and moving in an extremely powerful magnetic field. The pen is intermittently pressed against the paper by means of an accessory electromagnet in the base of the instrument, worked by means of a main current or by a single separate cell if desired, the contacts controlling this movement are carried by the clockwork in the drum.

The electrical portion of the dead beat recording ammeter for direct currents is a modification of the well known dead-beat ammeter sold by Messrs. Drake and Gorham; the recording portion can be fitted for continuous or intermittent records, the latter system avoiding the friction on the paper entirely. It is similar in external appearance to Fig. 3.

The dead beat recording voltmeter for direct currents, Fig. 3, differs only from the above in the proportion of the various parts and in the winding. It is remarkably free from hysteresis errors, and is probably more accurate than any recording instrument in use at the present time, though not so accurate as the photographic instruments which we describe below.

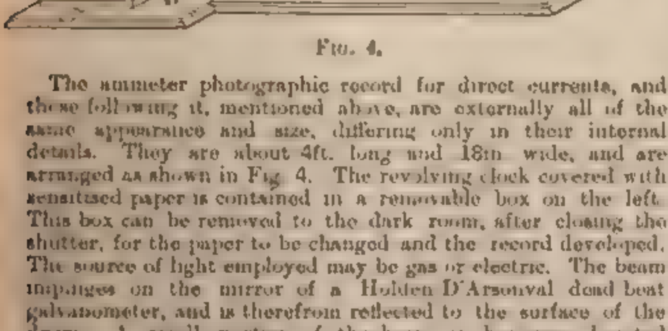


FIG. 4.

The ammeter photographic record for direct currents, and those following it, mentioned above, are externally all of the same appearance and size, differing only in their internal details. They are about 4ft. long and 18in. wide, and are arranged as shown in Fig. 4. The revolving clock covered with sensitised paper is contained in a removable box on the left. This box can be removed to the dark room, after closing the shutter, for the paper to be changed and the record developed. The source of light employed may be gas or electric. The beam impinges on the mirror of a Holden D'Arsonval dead beat galvanometer, and is therefrom reflected to the surface of the drum. A small portion of the beam is, however, directed upwards, and forms a visual pointer on a ground glass scale at the top of the box. The accuracy and convenience of this instrument cannot be surpassed. It is not affected by vibration, the presence of magnets, or any of the usual causes which so disturb the working of most instruments. The process of changing and developing the paper is a simple one; and, lastly, the power taken by this and the succeeding instruments does not exceed one watt.

COMPANIES' REPORTS.

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

Directors: His Grace the Duke of Marlborough, chairman; J. B. Braithwaite, Esq., jun. (of Messrs. Foster and Braithwaite); E. Garcke, Esq.; Aymer H. Sanderson, Esq.; Colonel Frederick George Steuart; R. H. Van Tromp, Esq.; Edward Woods, Esq.

Third annual report to be presented to the shareholders at the general meeting of the Company to be held at Cannon-street Hotel, London, E.C., on Friday, September 30, 1892, at 3 p.m.

The Directors beg to submit the balance-sheet and profit and loss account for the year ended June 30 last. The profit and loss account shows a gross profit of £55,757. 11s. 3d., inclusive of the amount brought forward from last account. After deducting standing charges, maintenance of buildings, plant, and patents, and interest on debentures and new debenture stock, there remains a balance of £27,660. 15s. 8d. The Directors recommend that, as in former years, £3,000 be applied to reduction of property, patents, and goodwill accounts, and £800 to reduction of preliminary and other expenses account. An interim dividend at the rate of 6 per cent. per annum upon both preference and ordinary shares, absorbing £11,553. 16s. 1d., has been paid for the six months ended 31st December, 1891, and the Directors recommend that £11,553. 16s. 1d. be applied to the payment of a further dividend, making 6 per cent. per annum upon both classes of shares; the balance of £753. 3s. 6d. being carried forward to next account. With a view to providing additional capital for extensions at the Loughborough Works, and to enable the Company to deal adequately with contracts on hand for electric lighting and other work in the City of London and elsewhere the capital account has during the past year been increased by the issue of shares to the amount of £11,223. During the year the £75,000 6 per cent. mortgage debentures of the Company have been redeemed by the issue of £125,000 4½ per cent. perpetual debenture stock, of which the major portion was issued to holders of the £75,000 mortgage debentures at the rate of £110 4½ per cent. debenture stock for each £100 6 per cent. mortgage debenture. The amount of this premium has been added to the property, patents, and goodwill account. The capacity of the Company's works at Loughborough has been increased during the past year by the erection of additional buildings and plant, and the Company is now in a favourable position for undertaking large central station and other contracts. Further additions with a view to the concentration of the Company's manufacturing operations at Loughborough are now in progress. The locomotive and rolling stock department continues satisfactory, and important contracts have been carried out during the year. The vertical steam engines manufactured by the Company specially for driving electrical machinery also continue to grow in favour, and numbers have been supplied to other firms engaged in the electrical industry. Satisfactory advance has been made with the City of London electric lighting contract referred to in the last report, and the plant already installed is now regularly supplying public and private electric lighting in a large part of the City of London. The plant so far erected for the City of London Electric Lighting Company represents only a small portion of the total work to be done for that Company, and in view of the numerous applications which have been received for light in the City of London, it may fairly be anticipated that the work to be executed during the current year under this contract will add very materially to the volume of business. The Company has also during the past year secured large contracts from municipalities for the equipment of electricity supply stations in several of the leading towns of Great Britain; and the prospects of other local authorities deciding to carry out central station works, and of this Company sharing fully in the execution of such orders, are encouraging. The Directors deemed it advisable to make a comprehensive exhibit of the Company's manufactures at the recent Crystal Palace Electrical Exhibition, and there is every indication that the results will justify the course adopted. The whole of the cost connected therewith has been written off in the profit and loss account before arriving at the net balance shown. The Directors submit, as before, a separate balance-sheet of the Company's foreign and colonial branches at Vienna, Temesvar, and Australia. The Austrian and Hungarian businesses of the Company have made good progress during the past year. Negotiations in connection with a rearrangement of the Company's interests in both businesses are still in progress. The policy of establishing a branch of the Company in the Australasian colonies is now bearing fruit. Some important contracts and sales have been effected, and others are under negotiation. The Company own the Edison patents throughout Australasia; and recent decisions in the New South Wales courts have confirmed these patents as controlling the sole right to the manufacture and supply of incandescence lamps. Mr. E. Garcke has resigned the position of managing director, but retains his seat at the Board. Messrs. John S. Raworth and R. Percy Sellon, who formerly held the positions of chief engineer and assistant manager respectively, have been appointed joint managers. Messrs. E. Woods and E. Garcke retire by rotation, and offer themselves for re-election.

BALANCE-SHEET, JUNE 30, 1892.

Dr.	£ s. d.	£ s. d.
Authorised capital	750,000 0 0	
Capital issued, viz.:		
75,000 6 per cent. preference shares of £2 each	150,000 0 0	
78,383 ordinary shares of £3 each	235,149 0 0	
		385,149 0 0

4½ per cent. perpetual debenture stock				£111,347	0	0
Creditors—						
Sundry creditors (including £22,365 6 per cent. mortgage debentures to be paid off on Dec. 1, 1892)	59,624	8	8			
Bills payable	19,055	14	4			
				78,680	3	0
Reserve account, as per last account, less £1,195. 15s. 5d. applied during the year	3,080	0	9			
Ditto received on contracts in course of execution	15,100	0	0			
				18,180	0	9
Balance of profit and loss account	27,660	15	8			
Less interim dividend paid on preference and ordinary shares	11,553	16	1			
				16,106	19	7
Note.—Contingent liability in respect of uncalled capital on shares in other companies on guarantee and on bills receivable discounted £12,701 8 7						
				£609,463	3	4

Cr.	£	s.	d.	£	s.	d.
Property, patents, and goodwill—						
As per last balance-sheet				266,270	19	10
Additions to buildings	964	2	1			
Additions to plant	1,761	3	7			
Expenditure on new inventions	558	9	3			
Redemption of debentures	7,500	0	0			
	£10,783	14	11			
Less written off last year and amortisation of leases	3,733	6	10			
				7,050	8	1
				273,321	7	11
Stocks—						
Goods in hand in process of manufacture and materials at London, Loughborough, and other places				77,900	18	7
Debtors—						
Sundry accounts (after provision for doubtful debts)	105 706	1	3			
Bills receivable	465	0	9			
				106,171	2	0
Cash at bankers, in hand, and at call				25,900	4	10
Shares and debentures in other companies				39,399	0	0
Provisional orders account, as per last account, less amount charged to contracts during the year				500	0	0
Preliminary expenses, as per last account	1,261	15	8			
Expenses of share and debenture issues	1,743	6	7			
	3,005	2	3			
Less written off last year	630	0	0			
				2,375	2	3
Liquidators' balances and suspense accounts				1,068	1	9
Balance of foreign and colonial branches accounts, being excess of assets over liabilities				82,737	6	0
				£609,463	3	4

Dr. APPROPRIATION ACCOUNT.	£	s.	d.
Further dividend on preference and ordinary shares at the rate of 6 per cent. per annum	11,553	16	1
Reduction of property account	3,000	0	0
Reduction of preliminary and other expenses	800	0	0
Balance carried forward	753	3	6
	£16,106	19	7

Cr.	£	s.	d.
Balance	16,106	19	7
	£16,106	19	7

PROFIT AND LOSS ACCOUNT, YEAR ENDED JUNE 30, 1892.

Dr.	£	s.	d.
General charges—viz.:			
Directors' fees	1,875	0	0
Auditors' fees	52	10	0
Salaries	7,871	19	7
Staff bonuses	1,910	6	11
Law charges	438	13	2
Insurance	762	15	2
Postage, stationery, and printing	1,091	19	11
Travelling, carriage, and freight	1,667	8	5
Advertising, agency, and sundries (including £2,172. 7s. 11d. cost of Crystal Palace exhibition)	5,385	6	7
	20,055	19	7
Maintenance of plant and buildings	2,501	15	0
Maintenance of patents	396	10	11
Interest on debentures and debenture stock to 30th June, 1892	5,142	10	1
Balance, being net profit	27,660	15	8
	£55,757	11	3

Cr.	£	s.	d.
Balance from last account	306	11	5
Gross profit, including net profit of foreign and colonial branches	55,450	19	10
	£55,757	11	3

BALANCE-SHEET OF THE FOREIGN AND COLONIAL BRANCHES; being the balances of the following accounts: Vienna (made up to 31st December, 1891), Temesvar (made up to 30th June, 1892), Australia (made up to 30th April, 1892).

Dr.	£	s.	d.
Creditors: Open accounts and bills payable	63,234	14	3
Unpaid balance of purchase price of land secured by mortgage	7,250	0	0
	70,484	14	3
Balance of assets over liabilities transferred to general balance-sheet	82,737	6	0
	£153,222	0	3

Cr.	£	s.	d.
Property: For freehold and leasehold land, buildings, plant, tools, fixtures, etc., at Vienna, Temesvar, and in Australia	62,305	19	5
Stock: For goods in hand, in process of manufacture and materials	44,213	4	1
Debtors: Sundry accounts (after provision for doubtful debts) and bills receivable, including estimated profit to 30th June, 1892	42,211	14	2
Cash at bankers and in hand	2,815	18	7
Shares in other companies	20	0	0
Australian suspense items	1,655	4	0
	£153,222	0	3

NEW COMPANIES REGISTERED.

Bates Steel Company, Limited.—Registered by H. Ogden Mellor, 27, Clements-lane, E.C., with a capital of £350,000 in 35,000 shares of £10 each. Object: to carry into effect an agreement, made between W. R. Renshaw of the one part and this Company of the other part, for the acquisition of certain patents, patent rights, etc. (granted to F. G. Bates), relating to an improved process for the preparation of material for use in converting iron or low-grade steel into high-grade steel, and to develop and turn to account the same; as steel makers and converters, coal and iron masters, engineers, tool makers, chemical manufacturers, colliery proprietors, metallurgists, etc.; and to carry on the business of an electric light and power company in all its branches; to acquire lands and other property of any description, and to develop and turn the same to account in such manner as the Company may deem expedient; to search for and render marketable cryolite or any other material containing alumina, iron, etc.; to establish and maintain railways, tramways, wharves, piers, etc., roads, watercourses, etc.; as shippers and shipowners; as company promoters, and the general business of a financial agency. There shall not be less than three nor more than seven directors; the first to be elected by the signatories to the memorandum of association. Qualification, £1,000. Remuneration: Chairman, £375 per annum; ordinary directors, £250 per annum each.

Electro-Alkali Company, Limited.—Registered by Messrs. Bonner, Wright, Thompson, and Co., 165, Fenchurch-street, E.C., with a capital of £160,000 in £10 shares. Object: to adopt and carry into effect an agreement, expressed to be made between the Electric Construction Corporation, Limited, of the one part, and this Company of the other part, for the acquisition of certain patents, patent rights, licenses, etc. (referred to in the said agreement), relating to any chemical, electrolytical, or electro-chemical process, or to any apparatus, implements, or machinery used in connection with electricity, and to develop and work the same. The first subscribers are:

	Shares.
W. Young, 109, Crofton-road, Peckham-road, S.E.	1
F. J. Allen, 14, Trelawn-road, Brixton	1
F. Virgo, 98, Earl's Court-road, S.W.	1
W. H. McCarthy, 101, Brook-street, Kennington	1
J. Payne, 5, Richmond-terrace, Clapham-road, S.W.	1
J. R. Threadgold, 19, Shenley-road, Camberwell, S E.	1
S. T. Bishop, 6A, York-grove, Peckham	1

There shall not be less than three nor more than seven directors; the first are to be nominated by the signatories to the memorandum of association. Qualification, £100. Remuneration, £100 each per annum, with 10 per cent. on the gross profits of each year, and 10 per cent. on the amount realised by sales.

Electricity Supply Company of Croydon, Limited.—Registered by Harrison and Robinson, 263, Strand, W.C., with a capital of £40,000 in 7,900 ordinary shares and 100 founders' shares of £5 each. Object: to establish at Croydon a central station for the supply of electricity, and to maintain and carry on the same. With slight modifications, the regulations contained in Table A apply.

London Health Electrical Institute, Limited.—Registered by Mann and Taylor, 109, New Oxford-street, with a capital of £10,000 in £1 shares. Object: to carry into effect an agreement, made September 16, between G. I. Spalding and M. C. Spalding

of the one part, and T. J. Hartshorn, on behalf of this Company, of the other part, for the acquisition of the business now carried on under the style of the Magneto Electric Battery Company and the London Health Electrical Institute, or the Health Electrical Institution of London; to provide for the treatment of diseases by means of appliances employing electricity, etc. The first Directors are G. I. and M. C. Spalding. Qualification, £2,000. Remuneration, £600 and £300 per annum respectively.

BUSINESS NOTES.

Commercial Cable Company. The West-end office of this Company has been removed to 1, Northumberland avenue.

Agent Wanted.—Messrs. Clarke, Chapman, and Co. desire to appoint an agent, on commission, in the Birmingham district, *vide* p. xvi.

Belfast.—The Lighting Committee of the Belfast Corporation has decided to introduce the electric light to a limited extent, as an experiment in illuminating the city.

Western and Brazilian Telegraph Company. The receipts for the week ending September 23, after deducting the amount payable to the London Platino-Brazilian Company, were £4,009.

Coventry.—At the Coventry County Council on Wednesday, the Electric Light Committee reported that schemes and estimates for a central electric light station had been received from six firms.

City and South London Railway Company. The receipts for the week ending September 25 were £768, against £708 for the same period last year, or an increase of £60. The total receipts for 1892 show an increase of £845 over those for the corresponding period of 1891.

Workshop Lighting.—Messrs. Harpers, Limited, of Aberdeen, have placed an order for the electric lighting of their new workshops with the General Electric Power and Traction Company, Limited, of Kentish Town, London. Two of the new shops to be thus lighted are each equal in size to the Bethnal Green Museum.

Dundee.—The Eastern Club managers have given an order to the Dundee Gas Commissioners to light two flats of their buildings with the electric light. This is the first order the Commissioners have received since the electric lighting works were constructed. The system of mains in the central part of the town is being laid down.

Frizington. The Frizington Local Board have authorised Mr. Richards to obtain a water gauge and test the pressure of the water pipes, so as to judge whether they can obtain enough power to drive the electric light. The other members thought Mr. Richards should wait to see the result at Whitehaven, but he was accorded his water gauge.

Police Signal System. At the Liverpool Watch Committee, on a report from the head constable, it was resolved that it be recommended that an agreement be entered into with Messrs. Siemens Bros. and Co., Limited, for the hire of 50 signal lamp posts, together with the use of one office indicator for receiving messages from such lampposts.

Anglo American Telegraph Company. The Directors of this Company have declared an interim dividend for the quarter ending September 30, 1892, of 12s. 6d. per cent. on the ordinary stock and 25s. per cent. on the preferred stock, less income tax, payable on November 1 to the stockholders registered on the books of the Company on September 30, 1892.

Dublin.—The Electric Light Committee are advertising for a clerk and storekeeper at a salary of 30s. per week. Age not to exceed 30 years; a knowledge of electricity desirable, and a preference will be given to candidates who can write shorthand. Full particulars can be obtained of Mr. John Beveridge, town clerk, City Hall, Dublin. Applications are to be sent in by Oct. 3.

Eastern Telegraph Company, Limited. The Directors of this Company announce the payment on October 14 of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the preference shares for the quarter ending Sept. 30; and the usual interim dividend of 2s. 6d. per share on the ordinary shares, tax free, in respect of profits for the quarter ending June 30.

Maidstone. The Local Board have decided to engage Mr. W. C. Hawtayne to carry out the electric lighting scheme for the borough, at a salary of £300 per annum, on which terms he will be engaged for at least 12 months after he has got out the plans and put the scheme into working order. It is anticipated that the carrying out of the works will involve an expenditure of about £12,000.

Windsor.—The Town Council of Windsor invite tenders to supply with gas or other material for lighting, and to light, extinguish, and keep clean the public lamps in the district of the borough of New Windsor. The tenders to be at per lamp for lamps lighted at sunset and extinguished at sunrise, for one year. Tenders to be delivered at the town clerk's office, 4, Park street, Windsor, by October 8.

Barnet. At the last meeting of the Barnet Local Board a letter was read from Messrs. Joel protesting against the charge of £17 for the removal of the electric light posts, and asking for details and vouchers. They objected that the charge of £8. 15s. 2d. for kerbing was exorbitant, as the person who removed the posts was employed to fix them, and had the kerbing in his possession. The clerk was instructed to furnish Messrs. Joel with the details asked for.

Mexican Telephones.—It is stated that a new telephone company is to be started in Mexico, of which the promoters and managers will be Ernest and Enrique Ascorve. The capital will be 100,000dols. The name of the company is to be Compania de Telefonos de Mexico, and is to be composed entirely of Mexicans, from manager to smallest shareholders, though this is likely to be of doubtful advantage.

Bournemouth.—At the Bournemouth Town Council meeting last week, in reply to Councillor Trevanion, Alderman Ridley, chairman of the Lighting Committee, stated that the subject of the lighting of the pier, gardens, and public offices by electricity was under consideration. They had found that the lighting of the public offices alone was much more economically carried out by the company than by the Corporation. Councillor Hankinson said if the gardens and pier were lighted he had no doubt the cost would be less.

Colliery Engineering.—Mr. Albion T. Snell, since he severed his connection with the General Electric Power and Traction Company, some five months ago, has been practising as a consulting engineer, making a specialty of electrical transmission of power, more particularly with reference to colliery and mining work. This is a field in which he has had many years' practical work. And in order to ensure the highest degree of efficiency in work entrusted to him by colliery proprietors and mining managers, he is consulting with Messrs. Walker and Hardwick, mining and civil engineers, of Sheffield and London. Mr. Albion T. Snell's offices are at Suffolk House, Laurence Pountney hill, London, E.C., and North Church street, Sheffield.

Beckenham.—At the Beckenham Local Board meeting a letter was read from the Crystal Palace and District Electric Supply Company, Limited, in reply to the Board's complaint as to the non-completion of the Company's mains and the supply of electricity in the Crystal Palace district. The secretary to the Company wrote trusting there would be no necessity for the Board to take any action in regard to the matter, and explaining that the delay had been caused solely in consequence of some differences of a technical character between the Company and their contractors. Some of the mains in the district had already been laid, and the work would now be immediately proceeded with. As soon as the sub-station had been completed a supply would be available for use. The letter was referred to the Works Committee.

Camberwell. At the meeting of the Camberwell Vestry last week permission was given to the Commissioners of Public Baths and Washhouses to erect two standard lamps at the corner of Artichoke row and Church street, to be lit by electricity. The new baths, Mr. Wallace stated, were to be lighted by electricity, and the Commissioners were anxious to show the parishioners that they were desirous to taking the lead in regard to electric lighting. At a subsequent stage, Mr. Wallace, on behalf of the General Purposes Committee, reported that a notice had been received from the Board of Trade revoking the Camberwell electric lighting order, 1891, as confirmed by the Electric Lighting Orders Confirmation (No. 9) Act, 1891, as from August 26, 1892. The order referred to the Camberwell and Islington Electric Lighting Company.

Fleetwood.—A note elsewhere on Morecambe shows that the Fleetwood people are wishful of having the electric light. The Highway and Lighting Committee have recommended unanimously to authorise the clerk to enter into correspondence with the following firms with reference to electric lighting, with the request for reports as soon as possible: Messrs. Hammond and Co., Mr. Thomas Barton, and Mr. E. J. Jennings. It was also determined that a special letter, with reference to reports already deposited, should be sent to the following firms: Messrs. Crompton, Messrs. Ferranti, Messrs. Gordon, the Brush Electrical Company, and Mr. J. K. Grindrod. The clerk stated that they had had replies from two firms, and the representative of one had been in Fleetwood that day. Representatives of other firms had intimated they were coming.

Volk's Electric Railway Staff's Outing.—Owing to requirements of the traffic on the Brighton Electric Railway, an ordinary "beanfeast" could not be held. Arrangements were therefore made for the party to leave Brighton on Saturday night by the 8.30 p.m. train for Newhaven Wharf, crossing by the night boat to Dieppe. Arriving there between 3 and 4 a.m. they put up for a few hours at an hotel, then spent the morning in visiting the churches and other interesting objects of the quaint old town. After lunch a drive was taken to the Forest and the Chateau d'Arques. Dinner and a stroll occupied the evening, and the party left Dieppe at 1 p.m. on Monday, arriving at Brighton at 8 a.m., the whole party having thoroughly enjoyed the outing. The weather proved very fine and the sea smooth. Mr. Magnus Volk accompanied the excursionists.

Acton. The Brentford Gas Company have raised the price of their gas 3d. per 1,000ft. When the notice of this fact was read at the Acton Local Board the idea was expressed that this would hurry on the electric light. The chairman said a good many private firms were beginning to ask what the Board intended to do with regard to electric lighting, but the Board thought it desirable to see how the experiment at Chiswick succeeded. Alderman Lingham very justly expressed the opinion that electric lighting was so generally adopted that the Board need scarcely wait for the experience of Chiswick. Mr. Bradford said country towns were very much in advance of London suburbs in this matter of electric lighting. The chairman thought the Finance Committee might

prepare a scheme whereby a contractor would undertake to supply the light on certain terms, and on the proposition of Mr. Miller, seconded by Mr Fox, the Finance Committee were instructed to consider the question and report.

Smithfield Market. – The scheme for lighting the Smithfield Market is likely to prove an interesting and striking example of the usefulness and economy of the electric light. The installation, which has been carried out by Messrs. Julius Sax and Co., has been arranged under the superintendence of Mr W. H Massey, M.I.E.E., of Twyford, and will be shortly ready for lighting. It is interesting to note that only some £35,000 capital will have been required to put down the necessary plant to bring in an annual rental of at least £15,000 during the early hours of the morning alone, so that the plant would be free to do lighting outside the markets in the evening if the terms of the concession allowed. The installation will be shortly formally opened by the Lady Mayoress, accompanied by the Lord Mayor. Under the terms of the concession the tenants will not have to pay for fixtures, and will only be charged the same price as gas. There will be in all 8,000 lamps of 50 c.p. each, and the installation will evidently become quite one of the show places of London, interesting both electrically and financially to engineers and municipal bodies.

Huddersfield. At the Huddersfield County Council monthly meeting the Gas Committee minutes showed that at a meeting of the Electric Lighting Sub-Committee on August 19, applications were submitted from Messrs. B Hirst and Sons, contractors for the joiners work, and Messrs Henry Brook and Co contractors for the ironwork at the electric lighting station, for payment on account of the materials prepared at their works for the building; and it was resolved that the borough electrical engineer be instructed to ascertain and value the amount of the work done on the contractors' premises, and grant certificates for such amounts as he might consider they were entitled to under their contracts. Alderman C. Glendinning objected to this resolution of the committee, as setting a bad precedent. Alderman Stocks explained that it was on account of a strike which prevented the electric light works from being proceeded with for nearly two months, although the material was ready at the contractors. The minutes were adopted.

Fire Brigade Telephones. – The Fire Brigade Committee of the London County Council report that on the advice of the chief officer, they have arranged that the existing link lines of telephone between districts which have been provided in case of the breakdown of the wires between the chief station and the superintendents' stations shall be abolished, and that, to guard against the possibility of such a breakdown, there shall be established between the chief station and each superintendent's station a duplicate direct line of telephone. The annual charge for the new lines is estimated at £120, but as the charge for the five link lines, amounting to £105 a year, will cease, the net annual increased expense will be only £15. They also report that they have arranged for an alteration in the method by which six of the stations in the south eastern district now temporarily connected by telephone with the chief station shall by means of a switch in the chief station be placed in direct communication with the superintendent of the district at Camberwell. The result of the arrangement will be that the annual charge for the telephone apparatus will be reduced by £10 10s.

City of London Electric Lighting Company. – This Company was formed in 1891 to supply electricity throughout the City of London. Our readers are probably fully acquainted with the history of the Company, which has a share capital of £800,000, of which 40,000 ordinary £10 shares have been subscribed and allotted, and now a new issue of 20,000 preference shares are offered for subscription. These shares are cumulative, 6 per cent. of £10 each. It is intended to issue the remaining portion of the preference shares next year. It would perhaps be injudicious of us to go far out of the details of the prospectus now put before the public, but from our own information we know that the orders in the hands of the Company are very extensive, and that they can fully employ the capital they are asking for. As will be seen from the prospectus, signed applications for current for over 40,000 8 c.p. lights have already been received, of which only about 16,000 are being supplied, and the remainder will be connected to the Company's mains as soon as the additional plant is available. We consider that this Company has as good prospects in the future as any company, of whatever kind, ever started for the production of artificial light. A great success needs only a judicious utilisation of the capital subscribed and we fancy the strong Board of Directors will be sufficient evidence to the public that the capital subscribed will be judiciously utilised.

Chatham. – In pursuance of his movement to purchase the electric lighting works by the Chatham Town Council, the Mayor of Chatham has collected some very interesting particulars, which he has embodied in a report to his colleagues, who will shortly consider the matter. The following is perhaps the most interesting portion of the report. "The Electric Lighting Acts allow local authorities who undertake to supply electricity to make a profit equivalent to 5 per cent. per annum on the outlay capital. Now if the Chatham Corporation undertake the business, it will be in a position to appropriate for the relief of local rates on the expenditure of £30,000 the sum of £1,500, which would be equivalent to a rate of 6d. in the pound. By expending an additional sum of £10,000, and so bringing the capital expenditure up to £40,000, the capacity of the Chatham station could be doubled. This would have the effect of reducing the cost of production, whilst enabling £2,000 per annum to be appropriated for the relief of the rates, and this could be still further improved upon by doing all public lighting free of cost. At the present time the Corporation of Chatham are probably spending £1,000 per annum in gas for public lighting. The £1,000 thus saved, added to the £2,000 already shown, would be a total of £3,000 per annum, which would practically be equivalent to a rate of 1s. in the pound. Under such an arrangement as the foregoing, the public streets would be far more brilliantly lighted than at present, whilst the consumers would get their light from 20 to 40 per cent. cheaper than a private company could supply it, in consequence of the Corporation being in a position to command money at a much cheaper rate."

The Blackpool Electric Tramways. An extraordinary general meeting of the Blackpool Electric Tramway Company was held at Blackpool last Saturday for the purpose of winding up the Company. It will be remembered that about three weeks ago the Blackpool Corporation took over the management of the electric trams, the Directors of the Tramway Company having accepted an offer of £15,750 for the whole of the plant, stock, etc. Mr. J. Horsfall presided, and, as chairman proposed that the Company should be voluntarily wound up. Mr Thomas Bottomley, of Marsden, near Huddersfield, seconded the motion, and after a short discussion the resolution was passed unanimously. Upon a vote of thanks being proposed a noisy scene occurred. After supporting the vote, Mr. J. Wheway said that the Blackpool Corporation had not treated the Company with the consideration they merited. The tramway had been one of the principal means of bringing people into the town, but the bargain which the Corporation had struck in purchasing the tramways reflected dishonourably upon them. A scene of confusion followed upon these remarks, the Mayor of Blackpool (Mr. H. Buckley) rising and asking Mr. Wheway to withdraw what he had said. Mr. Wheway refused, and was proceeding to remark upon a strong body of men having taken advantage of a weak body, when there were further loud interruptions, and a further objection from the Mayor of Blackpool. After the noise had subsided, Mr Wheway said he did not honour the men who had taken his property and not given him that to which he was entitled for it. The Mayor of Blackpool again asked Mr. Wheway to withdraw his remarks, but again met with a refusal. The vote of thanks was then carried, and the proceedings concluded.

Leeds. – The Yorkshire House-to-House Company promise to supply light in Leeds within two months. An arrangement has been made with the Highways Committee for Corporation staff to open up the streets for the mains, and the station arrangements are being rapidly pushed forward. The following prospectus, embodying scale of discounts, have been published:

"All accounts, whether small or large, for electricity are subject to a discount from the standard price of 8d. per unit, based upon the number of hours per quarter during which the current is used, each consumer being called upon to declare the maximum number of lights required to be in use at any one time. The scale of discounts is as follows:

For not less than	250	hours' use	(per quarter)	of the supply demanded,	10	per cent.
,, ,,	375	,,	,,	,,	15	,,
,, ,,	500	,,	,,	,,	20	,,
,, ,,	600	,,	,,	,,	$22\frac{1}{2}$	,,
,, ,,	700	,,	,,	,,	25	,,

In addition to the discounts accruing under the above table a discount of 5 per cent. will be allowed on the net amount of accounts paid within one month from the date of rendering and $2\frac{1}{2}$ per cent. on accounts paid within two months. The effect of the discounts above mentioned is to reduce the price of 8d. per unit to about the following net charges:

For	250	hours' use	(per quarter),	$6\frac{3}{4}$d.	per unit.
,,	375	,,	,,	$6\frac{1}{2}$d.	,,
,,	500	,,	,,	6d.	,,
,,	600	,,	,,	$5\frac{3}{4}$d.	,,
,,	700	,,	,,	$5\frac{1}{2}$d.	,,

It is pointed out that the most liberal discount is not necessarily given to the consumer with the greatest number of lights, but to the consumer who uses the lamps he has most regularly, and for the longest hours, as he will be the best customer. There being no storage, the machinery will be kept going whether current is used or not, and the desire of course is to foster regular demand. Shallenberger meters will be used on the Leeds system."

Morecambe. – A deputation from Fleetwood recently visited Morecambe, where the electric light is in full swing, and were welcomed by Mr Collinson, the superintendent and engineer. The station is run by a private company, with gas engines and accumulators. The dynamos are driven by three gas engines, and the company are putting down plant to make their own gas. They have sufficient machinery at present to supply 1,600 8 c.p. lamps. The station only commenced running last Whitsuntide, but already they have application for more lights than they can supply, and fresh accumulators are being put down. They have a contract with the Local Board for public lighting, but are not yet able to carry it out. The cost of the plant complete was £4,500. Some interesting statements were made by the customers as to the cost of the light, several of them stating their bills were less than for gas. Mr Cutts, chemist, was quite enthusiastic. Previously his establishment took nine gas jets, and for these he had substituted nine 8 c.p. lamps, which gave a better, brighter, and clearer light. With gas at 3s. 11d. a thousand his bill used to be £10 to £12 a year, while the electric lamps cost him 10s. a lamp, or £4 10s. a year. He was satisfied with the service, quality, and price, and recommended the Fleetwood gentlemen to go in for electric light at once. Mr. Widdup,

another customer, had only a summer season trade, using little light in the winter, and he found the two lights about equal. Mr. Bickett, another chemist, has eight lamps, making £3 12s., but as he has them on a three years' contract, with a reduction of 10 per cent. and 5 per cent. for cash, his bill amounts to £3 8s. 6d. for electric light, as against £5 to £6 he used to pay for gas. We publish these figures as given by the customers to the Fleetwood Tradesmen's Association. At Fleetwood the gas is 4s. 2d. per thousand.

Bowness. A special meeting of the Bowness Local Board last week considered the application of Messrs. R. H. Fell and Sons, Limited, for permission to lay an electric cable in the Board's district. The clerk said he had arrived at the conclusion that it would be to the interests of the Board to insist that the company should obtain a provisional order from the Board of Trade unless very exceptional arrangements could be come to with the company. Under any other circumstances the securing a provisional order would be distinctly of benefit to the Board for the reasons (1) such order could only be made with the consent of the Board and with that of the Board of Trade, and it would become the duty of the Local Board to make suggestions as to the terms of the order. (2) The order would provide for a regular and efficient supply, for the public safety, for a limitation as to the rate of charging for the light, and for an official inspection of the works. (3) Such an order would empower the Local Board to make, and bring into force, by-laws for the further security of the public safety. (4) The company would have to publish its accounts annually, giving also to the Board an opportunity of applying to the Board of Trade to vary the terms of the provisional order if it was thought desirable to do so. (5) At the end of 40 years, or such shorter period as the Board of Trade might fix, and every 10 years afterwards, the Board could take over the company's works on lease at the rate of their actual value, without allowing anything for goodwill; or they could be taken by compulsory purchase on prospective profits. After complaints upon the bad quality of the gas a discussion was held on the desirability of obtaining a provisional order. Mr. Fowkes, representative of the company, was called in, and the chairman asked him whether, assuming the company obtained a provisional order, it was likely they could come to reasonable terms for purchase at the end of seven, 14, or 21 years. Mr. Fowkes, in reply, said seven years was too short a time. The company were undertaking all responsibility and risk, and if the concern did not turn out a success, the company would lose all and the Board nothing. If the Board combined with any other authority in the purchase, he did not think the company would hesitate about arranging terms either at the end of 14 or 21 years. With regards to price, he thought the price of street lamps would be 8d. per unit, but they should not think of starting at less than 10d. a unit for the private lighting. After a prolonged further discussion Mr. Holland proposed a motion to the following effect: "That this Board recommend the County Council to sanction the laying of an electric cable along the main road through the Bowness Local Board district as required by R. H. Fell and Sons, Limited, providing the same be put down to the satisfaction of the surveyor." This was understood to include permission from the Board to put down wires along the by-roads, subject to similar conditions. The resolution was agreed to.

Government Enquiry at Whitehaven. Mr. Rienzi Walton, one of the inspectors of the Local Government Board, held an enquiry, last week, at the Town Hall, Whitehaven, with respect to an application by the Town and Harbour Trustees to borrow £14,980 for the electric lighting of the town. Mr. T. Brown, solicitor to the Trustees, explained that the scheme was divided into two parts—public lighting and private lighting. Regarding the public lamps, the whole of the present area would be lighted by electricity, with the exception of a small area consisting of some 70 or 80 houses, which were so situated as to be difficult of access and would be very costly to supply. The private supply in the first instance would be to the principal business and residential parts of the town, including the main shopkeeping streets and residences of higher value which were likely to use electric lighting. The generating station would be in connection with the sewage pumping station. At this place steam had at present to be kept up day and night in order to prevent flooding of the sewers. The building itself belonged to the Trustees, so that they would have no land to buy and no buildings to erect. All the structural expenses they would incur would be for new foundations in the present building. Two new boilers would be put in of 250 h.p. each, and these boilers would be ample for both the pumping and the electric lighting. The dynamos would be driven by four of Willans engines. If they required to extend their operations, they had room in the building for four more engines. The public lighting would be by the two-wire system, and the private lighting by the three-wire system. The public lighting would be put on and cut off direct from the generating station. The cost of the plant was estimated at £13,940, including structural alterations to buildings, which only amounted to something like £500, and all the capital outlay for the public supply for the town and the private supply contemplated under the present scheme. The public lighting would be carried out by 500 incandescent lamps, mainly of 16 c.p., with some of 32 c.p. The revenue to be derived from both public and private supply it was considered would show a profit. In the running charges he gives for maintenance of machinery and fixtures, £250; interest and sinking fund, £980; wages, £360, excluding wages on repairs; coal, £200; water and stores, £40; maintenance of accumulators, £87. 10s.; maintenance of machinery and conductors, £220. The item interest and sinking fund is reckoned at 7 per cent. on 20 years' purchase, but he asked for more than this—30, 35, or 42 years, which would make Dr. Hopkinson's estimate, the total of which is £2,057, considerably less. In the receipts there is, first, an item of £400 for pumping; this is the sum now paid, and will be saved, as the double work of electric lighting and pumping will be carried on in the same building and with the same staff. £1,000 is put down for public lighting; the amount now paid is £1,150 for gas, the Corporation owning the lamps and keeping them in order. Dr. Hopkinson's estimate for private lighting was £1,400. This was the estimate, and applications have already come in for £507, so that with the pumping, public lighting, and private customers there would be an income of £1,907 against an expenditure of £2,057. In other words, with £200 more private revenue they would have a clean sheet; and with 42 years' borrowing powers, instead of 20, the item of £980 would be reduced to about £500. So that with a fair number of years to spread over the sinking fund the scheme would show no loss. The Trustees were unanimous in thinking it was to the interest of the town to put the provisional order in force. The estimate of cost was £13,940, and the estimate for possible extensions £7,038, and on looking at the applications which had come in, Dr. Hopkinson and the chairman were of opinion that the items for engine and dynamos would be required to be extended in the immediate future; they would therefore apply for the amount for extensions as well. Dr. Hopkinson was then called. He said the engines would be of small size—60 h.p.—because the whole work was on a comparatively small scale, and it was desirable to multiply the number of units. They are condensing engines. The boilers will be Lancashire or Galloways—two at first. There is little to add to the building, the shell remaining as now. The supply is direct with accumulators. There will be four sets of engines and dynamos, and room for four more. There will be six miles of mains, mostly for street lamps. There will be 500 or 510 incandescent lamps, 16 c.p. and 32 c.p., placed on present lampposts. Each machine is 60 h.p.; the boilers would be of 250 h.p. The potential would be 200 volts for street and 100 volts for private lighting. The whole of the charges include pumping, and the town will effect an economy of £150 a year for lighting. According to the applications coming in, the extension would be certain and necessary. There was no opposition, and the enquiry then adjourned.

St. Pancras. The rapid spread of electric lighting in London is well exemplified in the St. Pancras installation. The load is even now 75 per cent. of the total amount taken up, and will soon be 100 per cent., so that further plant will be necessary. It is expected that recommendations will be made at once to the Vestry for extension by Mr. Barton, the resident engineer. The installation has some very large customers on its mains, Maple's have 800 lamps, Shoolbred's nearly 2,000, the Railway Clearing House 1,800 lamps. The output rises in an astonishing manner about 5.30 p.m., a rise from about 400 to 3,000 amperes taking place in about 10 minutes. The public lighting of Tottenham Court-road being so successful, arrangements are being made to light up Hampstead-road to The Brecknock shortly. The meters mostly used are Ferranti's meters, of which the St. Pancras Vestry are now one of the largest users, and meters up to 300 amperes are employed. It will be interesting to have a record of the terms and conditions of supply adopted by the St. Pancras authorities. They are as follows:

"*Vestry of St. Pancras. Application for Supply.*—Application for current to be made on printed form attached, to be obtained at the offices of the electricity department, Vestry Hall, St. Pancras, London, N.W., stating whether for lighting, motive power, or other purposes, the number and candle-power of lamps, arc or incandescent; if for motive power the horse-power to be developed; if for charging accumulators, etc., the amount of current required. The date to be stated when supply is required (seven days' clear notice should be given). The maximum and ordinary supply of current to be stated in every case. The voltage will be 105 or 110 volts for incandescent lamps.

"*Connection with Consumer's Premises.*—The size and position of service mains entering a consumer's premises are to be determined by the engineer to the Vestry. Where the Vestry's distributing mains are close at hand or within 30ft. of premises proposed to be lighted, no charge whatever will be made to the consumer for bringing the service mains up to the premises to be supplied. The officers of the Vestry are not permitted to perform any private work for any customer, nor can they receive any payment or gratuity under penalty of dismissal. No addition shall be made to any installation that has been tested by the Vestry's officials, until due notice has been given on the form provided; failing this, the supply is liable to be stopped.

"*Meter.*—To be placed in a convenient place, as pointed out by the Vestry's engineer, all connections on the consumer's premises to the service lines and wires to be charged to and payable by the consumer. The meters are lent on hire, at a rental, according to size of meter, from 2s. 6d. per quarter (and are kept in repair). The consumer may have his own meter, but must keep it in repair. The Vestry may test the same, and if found incorrect may charge the consumer for testing. The Vestry may also fix a meter of their own to test the accuracy of the consumer's meter.

"*Alteration or Disconnection of Meter.*—The consumer must give not less than 48 hours' notice to the Vestry that he is desirous of having his meter or meters removed, and shall in no way interfere or tamper with his meter, the Vestry being empowered to withhold the supply until it has been enquired into and rectified.

"*Inspection of Meters.*—The inspection of meters will be made monthly. The Vestry's inspector is entitled to free access at all reasonable times to take readings of meter, inspect or repair any

work in connection with the service. The inspector shall at all times carry, when on consumers' premises, his inspection book, with his authority given under the common seal of the Vestry.

"*Inspection of Meters.* The reading of the meter shall be taken as to the quantity of current used, should the consumer dispute such reading, it may be officially tested, and if incorrect, the Vestry will add or deduct for such quarter only, and if the official test certifies the meter as correct, the consumer shall bear all expenses of the testing.

"*Price.* The price for current will be 6d. per Board of Trade unit equal to 15 16-c.p. 64 watts per lamp for one hour. In cases where the current is required for motive power the Vestry hope to be able to adopt a lower scale.

"*Payment.* Consumer's account will be made up quarterly (the 31st March, 30th September and 31st December), and payment should be made within the following 10 days of the date of such account. In case of non payment the Vestry may refuse to continue the supply.

"*Contract.* The consumer will be required to enter into a written contract with the Vestry. The consumer may be required to give security for the due payment of current used, and meter rent, also the care and safe custody of the meter.—By order of the Vestry."

The application form referred to above contains space for name and address of applicant, name of contractor who fitted up installation, number of lamps (arc or incandescent), and the candle power, if motors, approximate maximum current or horse power.

PROVISIONAL PATENTS, 1892.

SEPTEMBER 19.

16692. **Improvements in electrical apparatus for signalling or speaking between ships at sea or between ships and the shore, etc.** Sydney Ferris Walker, Cardiff Electrical Works, Severn road, Cardiff.

16700. **Improvements in electric fire alarms.** Robert Wood, New Bridge street, Manchester. (Edward Hoyle, Russia.)

SEPTEMBER 20.

16768. **Electrically controlled switching apparatus for telephone exchanges.** Robert Pappotte, 31, Endymion road, Brixton hill, London.

16775. **Improvements in keys for opening and closing electric circuits.** Alexander Muir, 70, Market street, Manchester.

16786. **Improvements in fittings for the support of electric lamps.** Wolf Defries and Victor Isidore Feeny, 11, Wellington street, Strand, London.

16805. **Improved portable electric search-light apparatus.** Ronald Augustus Scott, 46, Lincoln's inn fields, London.

16806. **Improved mode and apparatus for projecting images, characters, or the like on to distant bodies.** Ronald Augustus Scott, 46, Lincoln's inn fields, London.

16820. **Improvements in telegraphic and telephonic apparatus for establishing communication between signal boxes and trains on the line.** John Draper Hewson, 22, Southampton buildings, Chancery lane, London. (Complete specification.)

16822. **Improvements in electrolytic apparatus.** Thomas Craney, 15, Southampton buildings, Chancery lane, London. (Complete specification.)

16833. **Improvements in and connected with break feed appliances for electric arc lamps.** Frederick John Beaumont, 166, Fleet street, London.

SEPTEMBER 21.

16866. **Improvements in electrode plates for secondary batteries.** Adolph Müller, 47, Lincoln's inn fields, London.

16877. **Improved signalling apparatus for telephones.** Sir Charles Stewart Forbes, Bart., 21, Finsbury pavement, London.

16878. **Improved plates for secondary batteries.** Ernest Bailey and Jesse Hall, 21, Finsbury pavement, London.

16879. **Improvements in miners electric lamps.** Ernest Bailey and Jesse Hall, 21, Finsbury pavement, London.

16893. **Process and apparatus for the extraction separation and refining of metals by electrolysis.** Donato Tommasi, 53, Chancery lane, London. (Date applied for under Patents Act, 1883, Sec. 103, 21st May, 1892, being date of application in France.)

16903. **Improvements in and relating to electric accumulators.** Henry Harris Lake, 45, Southampton buildings, Chancery lane, London. (Frederick Clarence Jenkins, Germany.)

16904. **An automatic switch for electric and other light applicable to a door.** James Hopwood, 77, Chancery lane, London.

16906. **Improvements connected with audible telegraphs.** Richard Robert Harper, 166, Fleet street, London.

SEPTEMBER 22.

16919. **Improvements in and connected with dynamo-electric machinery alternating-current motors transformers, manufacture of ozone and oxide of nitrogen recovery of tin from scrap, electro plating with aluminium.** James Swinburne, Broom Hall Works, Teddington, Middlesex.

16934. **Improvements in voltmeters or electrical indicators.** William Henry Thompson and Robert Thompson, 155, Fenchurch street, London.

16948. **A mode of and means for enabling boats to be propelled on navigable ways by electric energy.** Ernest de Pass, 78, Fleet street, London. (Edmond Gunsenberger, Adolphe Seiler, and Ernest Gendenin, France.)

16964. **Insulating electrical conductors.** Sydney Pitt, 24, Southampton buildings, Chancery lane, London. (Edward Crawford Davidson, United States.)

SEPTEMBER 23.

16980. **Improvements in connections for electrical accumulators and other similar purposes.** John Joseph Robins, 12, Cherry street, Birmingham.

16997. **Improvements in electric bells.** Thomas Gibson Usher, Robert Usher, and Robert Charles Usher, 46, Lincoln's inn fields, London.

17004. **Improvements in electric arc lamps.** Frederick D'Artrey Gould, 11, Brackley terrace, Chiswick, London.

17012. **Improvements in and relating to the distribution of electrical energy.** George Wilkinson, 41, Furnival street, London.

17013. **New and improved means and apparatus for utilising the expansion and contraction of liquids for the purpose of driving machinery.** Charles Mackintosh, 22, Glasshouse street, Regent street, London.

SEPTEMBER 24.

17091. **Improvements in insulating and supporting electric wires intended to act as resistances.** Rookes Evelyn Bell Crompton and Herbert John Dowsing, 55, Chancery lane, London.

17092. **Improvements in insulating and supporting electric wires intended to act as resistances.** Rookes Evelyn Bell Crompton and Herbert John Dowsing, 55, Chancery lane, London.

17093. **Improvements in electrostatic measuring instruments.** William Edward Ayrton and Thomas Mather, The Central Institution, Exhibition road, London.

17099. **An improvement in carbon electrodes.** Harry Theodore Barnett, 14, Narcissus road, London.

SPECIFICATIONS PUBLISHED.

1891.

8031. **Heating and welding by the electric arc.** Howard. (Second edition.)

15075. **Electric lamp.** Thompson and Pyne.

15299. **Electrical signalling apparatus.** Lake. (New Haven Clock Co.)

15403. **Actuating electrically-propelled tramcars.** Bush.

15440. **Electric conductor.** Twigg.

17758. **Secondary batteries.** Mining and General Electric Lamp Company, Limited, and Niblett.

17907. **Electric signalling.** Swinton.

18551. **Electrical terminals.** Hall.

18775. **Electric bell indicators.** Siemens Bros. and Co., Limited, and others.

18974. **Electrical furnaces for making phosphorus, etc.** Parker.

22627. **Electric locomotives.** Hollingsworth.

1892.

1571. **Incandescence electric lamp.** Fremont and Nouvelle.

7264. **Electric arc lamps.** Harrison.

7404. **Electric railways, etc.** Short.

9341. **Electric propulsion of railway cars, etc.** Grantland.

11592. **Ammeters, etc.** Mills. (Pilkington and another.)

11943. **Electric fire alarms.** Cortland.

12238. **Electric currents.** Scheithauer.

12818. **Electric railways.** Evans-Jackson. (Huestis.)

13919. **Incandescent electric lamps.** Thomson.

13996. **Electrical generators.** Henry.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3
Pref.	—	[illegible]
City of London	—	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
House to House	5	[illegible]
Metropolitan Electric Supply	—	[illegible]
London Electric Supply	5	[illegible]
Swan United	$3\frac{3}{4}$	[illegible]
St. James	[illegible]	[illegible]
National Telephone	[illegible]	[illegible]
Electric Construction	10	[illegible]
Westminster Electric	—	[illegible]
Liverpool Electric Supply	[illegible]	[illegible]
	5	[illegible]

NOTES.

Ardrossan.—The electric light has been introduced at the Ardrossan harbour.

Toronto.—An electric tramway, five miles long, has been recently opened in Toronto.

Belfast.—The special committee on electric lighting hold their final meeting next week.

Electric Cars at Christiania.—The first electric tramcars in Norway are to be run at Christiania.

Telephones.—It is stated that the Government intend to purchase a number of the trunk telephone lines at once.

Havre.—A concession for an electric railway between Havre and Montvillier is asked by M. Burton from the municipality.

Brest.—The Société Weyher and Richemond is building three 150-h.p. engines for the electric installation of the French port of Brest.

Lecture.—In the programme for the Edinburgh Literary Institute Mr. E. A. Browning is down for a lecture on "Electric Light in our Homes."

Brussels.—The new post and telegraph office is entirely lighted by electric light, although the official opening of the building has not yet taken place.

Paris.—The accumulator traction tramway in Paris has met with an unexpected stoppage in the refusal of the Northern Railway to allow it to traverse its railway lines at the docks.

Antwerp Railway.—The negotiations for the establishment of an electric railway between Brussels and Antwerp are proceeding with vigour. M. Van den Kerchove is the promoter of the scheme.

Madrid.—A concession for an extensive system of underground electric railways in this city has been granted, says *Industries*, to an architect in Barcelona. It is generally considered that the project has little chance of being carried out.

Condensers.—M. Désiré Korda has given some attention to the effect of condensers in the secondary circuits of transformers, and has communicated a note thereon to the Académie des Sciences. Further communications are promised.

Dundee.—As will be seen elsewhere from their advertisement, the Dundee Gas Commissioners invite tenders for switchboards and instruments, to be sent in by the 22nd inst. The engineers are Messrs. Urquhart and Small, 17, Victoria-street, S.W.

Mains.—MM. Lazare Weiler and Henry Vivarez have recently published at Librarie Masson, Paris, a work on "Electric Lines and Transmission of Force." The book has an appendix giving the legislative position of electric conductors in France, Germany, and Belgium.

York.—The Corporation of York, invite by advertisement, this week tenders for the first instalment of their central station plant, and supplementary tender for extensions. Specifications and sketch plans are issued for a fee of £2. 2s., and tenders must be in by November 21st.

South American Cable.—Notification is given of the opening of a new submarine telegraph route between Europe and South America by this company's cables from Senegal to Pernambuco, in connection with the Spanish National and Eastern Companies' systems between London and Cadiz.

Zermatt.—This well-known Swiss town is to be shortly lighted by electric light, with power obtained from a glacier stream three or four miles away. A pressure of 2,200 volts will be generated by two sets of turbines and dynamos, to light at first 1,500 lamps. M. Palaz is the engineer.

Traffic in the City.—The additional centres at the Mansion House crossing in the City serve to some extent to reduce the danger to passengers at this crowded spot. But the police authorities are counting upon the facilities to be given in the intended central electrical railway to reduce the danger and discomfort to the required extent.

Aix-les-Bains.—Projects are being discussed for the introduction of electric light at Aix-les-Bains. The gas company offers an installation of 1,000 lamps by 1893, at 45f. per 10-c.p. lamp, and 55f. per 16-c.p. lamp from dusk to 1 a.m. Several companies have offered to instal a station and supply current one-third less than the gas company, and to run a day and night service as well.

Belfast.—Mr. J. C. Bretland, M.I.C.E., city surveyor of Belfast, in his address on "Municipal Affairs in Belfast," before the Municipal and County Engineers, mentions that the present cost of ordinary gas lamps is £3. 5s. each, and the charge for gas 3s. 10d. per 1,000ft. Last year the Corporation obtained a provisional order to light the city by electric light, which is now in course of being carried out.

New York.—A new departure has recently been made in New York City in the way of electric street lighting. The new arc lamps on Fifth-avenue have been placed on posts in pairs, each lamp taking five amperes at the usual voltage. Each pair of lamps is connected in multiple on a low-tension circuit, thus permitting them to be fed with current from the same mains as the ordinary low-tension domestic service, and rendering a special circuit unnecessary.

Core and Shell Transformers.—Herr L. Imhoff has recently made calculations, which have been published in the *Electrotechnische Zeitschrift*, upon the relative advantages of transformers having an inside core and those having an exterior shell with interior winding. The calculations have been carried out from the formula of Steinmetz, and go to prove the superiority of the shell type, but it would have been more to the purpose if the calculations had been tested experimentally.

Electric Lamps for Customs Officers.—It is stated that in order to avoid the possibility of explosion while "rummaging" for contraband goods on board tank and other vessels carrying petroleum or explosives, the Customs officers are in future, by order of the Customs Board, to be supplied with electric lamps of a special pattern. Ruby-coloured lights for the examination of imported cases of photographic negatives in a dark chamber are also to be supplied to obviate the risk of spoiling the plates.

Anti-Gas League.—Now here is a really good idea, which we commend to the Association of Municipal Engineers. A league is in process of formation, so we hear, in France for the association of all those towns where gas is more than a certain amount (0·20f. per cubic metre) to press for reduction, reform and the introduction of electric light. The first meeting of this anti-gas league will be held at Lyons in October. If the English authorities are active they might have a similar league going by December, and we can promise them the best wishes and good help from electrical engineers.

The Telephone in Kent.—Since the merging of the South of England Telephone Company into the National Company's system considerable progress has been marked in telephonic work throughout Kent, and an important change is now being effected in the wires. Six independent gangs are engaged upon the main trunk wires in order to set up complete metallic circuits for doing

away with the earth currents, necessitating double instead of single wires, with almost as many more posts on the line of route. The wires are also erected upon the spiral system, similar to the Paris telephone wires, to prevent induction.

Fire Risks.—A lecture was recently given to the Insurance Institute of Manchester on "Fire Risks of Electric Lighting," at the Electrical Engineering Branch of the Manchester Technical School, by Mr. Haldane Gee, lecturer in electrical engineering. The methods of procuring electricity for lighting and motor purposes were described, and the chief methods of distribution of electrical energy explained. With the aid of a number of experiments, possible danger of fire was pointed out, which in every case was due to imperfect workmanship. It was shown that the electric light was the safest possible illuminant when the installation was perfect.

Protection of Mansions from Fire.—Many Irish landowners have recently purchased fire engines or otherwise added to their apparatus for the protection of their residences from fire, and H. L. Barton, Esq., J.P., of Straffan House, co. Kildare, has just received a new "Squires" engine from Messrs. Merryweather and Sons, of London. This machine will not only throw two powerful jets for fire extinction, but can also be used to drive a circular saw, churns, cream separators, dynamo for electric lighting, and other mansion, farm, and estate plant. The engine delivers 120 gallons of water per minute and upwards, and developes over 6 h.p. The pump can be put out of gear in a few seconds and a band put on the flywheel to drive other machinery.

Rotterdam.—The Rotterdam authorities, who have a splendid opportunity along the quays, are wishful of investigating the cost of electric transmission of power for the use in cranes instead of hydraulic power. The current would also be used for lighting. They chose, out of a number, MM. Haniel and Lucy, of Dusseldorf, and the new crane has been very successful. The motor takes 140 amperes at 110 volts, and can raise a maximum of 1½ tons 60ft. in 25 seconds. The Corporation intend to supply the electric service itself, and have invited several French and German companies to tender. We are not aware whether English houses have also tendered, but the decision is to be made very shortly. Only those companies who have had experience in central station work were allowed to send in plans.

Electric Sky Advertising.—The new advertising apparatus of Messrs. Romeike and Curtice is going to beat all other schemes by its vastness and daring. To write "soap" on the clouds by electric light, or invite to Buffalo Bill everyone who glances an upward eye, is a bold scheme, and possibly will prove a nuisance. As yet the scheme is too much of a novelty to comment wisely upon. Trials are being made at Buffalo Bill's grounds, but the apparatus is hardly yet up to expectations, and a new reflector is being made by Messrs. Crompton and Co., who have the matter in hand. Mr. Curtice expresses himself as having a great belief in the project, and the large advertisers are metaphorically eyeing the new apparatus as a hungry dog does a bone. We may yet see "sunlight" shining from the skies at midnight in London.

Koechlin and Mariotti Dynamos.—Entirely new types of dynamos it is difficult, if not impossible, to make, but a considerable variation in the ordinary type is seen in those of Koechlin and Mariotti, described and illustrated in *L'Electricien* for October 1. The machines have alternate interior and exterior poles, the later type of Mariotti being a solidly designed machine with very large armature. The advantages claimed by M. Mariotti, who is engineer to the Telephone Company of Zurich, are very low speed, specially suiting the dynamo for direct coupling, the invariable position of the brushes even for greatly varying loads; also good ventilation and facility of getting at the armature. The objection is the cost for small sizes. But for transmission of force, and for large dynamos for central station work, the Mariotti dynamo seems very advantageous.

Medical "Magnetism."—The popular craze for electric or magnetic treatment of disease by qualified or more often unqualified persons is taken advantage of by many so-called "inventors and patentees." The magnetic belts have been followed by magnetic boots and brushes. Most intelligent persons are beginning to have strong doubts as to the truth of the professions of the vendors of these articles, but it is a sad thing to see the newspapers tacitly favouring their introduction. The *Bristol Times*, for instance, in a presumably editorial note, advocates the use of "magnetaire," administered by one M. Lonsdale, on the ridiculous reason that "it is the nearest approach to the principle of perpetual motion yet known!" Really a little clearer knowledge of science should be obtained by its writers at the nearest technical school, and perhaps we should have an approach to the principle of the honest policy of only writing about what is understood.

Transformers.—The article upon the efficiency of transformers which we reproduce elsewhere is worthy the best attention of electrical engineers. We doubt whether such successful results in obtaining high efficiencies at low loads of transformers have ever before been made, and MM. Hutin and Leblanc are to be congratulated on their work in this field. As will be seen, the progress made is less in any pure theoretical advance upon mathematical calculation than ordinary common sense and engineering knowledge adapted to transformer work. It is possible, as suggested, that the manufacture of transformers of high efficiency at low loads will redirect the arrangement of distributing projects to the use of separate transformers for each customer. But this is to be doubted, as the sub-transformer station is often more convenient as well as more efficient. This does not detract, however, from the extreme importance of the investigation and experiments.

Electric Traction.—The subject of electric traction is ever present in the electrical engineer's mind as the one coming important problem. How is it to be solved—overhead, underground, or storage? Therefore the announcement of a treatise on the subject of electric traction by such a competent and well-known authority as Mr. Anthony Reckenzaun, C.E., has roused a considerable feeling of interest, not only in Great Britain, but in America and the Colonies, where we are told engineers are anxiously expecting the promised volume. This work is now before us, the full title being "Electric Traction on Railways and Tramways"; illustrated. (Biggs and Co., Salisbury-court), price 10s. 6d. We are not here giving a full notice of the book; we mention, however, that the book is full of practical details, with diagrams, descriptions, and illustrations of the most interesting electric traction installations in Great Britain, America, and the Continent. It has a very complete index.

Halifax.—A recent visit to Halifax revealed the fact that although this town has 60 arcs, and some 400 incandescent lamps alight (and therefore considers itself as the best electrically lighted town in the North), yet there is really very little doing in the matter of public electric light supply. Halifax is in the peculiar position of having its borders enlarged, and a strenuous fight is looked for at the November elections. The electric light question is therefore kept in the background for the present, though the Corporation have already obtained their provisional order, and the energetic mayor, Alderman Davis,

is understood to think well of a municipal scheme. In fact, the town is pretty sure to do its own lighting. It is a very public-spirited place, and although Messrs. Blakey-Emmott, who now carry on the present lighting—and carry it on well—have made overtures, in the shape of the Halifax Mutual Electric Company, to take the lighting, it is not likely that this will be done. After November some active steps are likely to be taken, and plans on an extended scale will be required.

Discussion.—There is something about the electric light (we think it must be the gas) that makes discussions on the point very lively, not to say scandalous. We noticed the meeting at Heckmondwike last week, and gave the result of it—namely, that a new committee was to be formed. The full report of this meeting is before us, and is stigmatised by the reporter as the most disorderly meeting in the history of the Board. The simple question, Shall an electric plant be put down at the expense of the town? turned shortly into recrimination, and even "liar" was banded about by two councillors. Fie! gentlemen; this is certainly not seemly. The difficulty appears to here, as elsewhere—"gas shares," mingled with the sentiment expressed by Mr. Crabtree, that "at my time of life I am not going to charge my brain with electricity." There would seem to be an opening for the sale of a good elementary primer during these town council discussions. A prospectus sent to each councillor of the towns discussing electric light might lead to a more intelligent and less personal discussion.

Incandescent Lamps.—A carefully-carried-out series of experiments on the life and efficiency of incandescent lamps, by Ch. Haubtmann, is given in *L'Electricien* for Sept. 24. The article is illustrated with a large number of tables and curves dealing with tests of incandescent lamps of the following makes: La Française, Gabriel, Swan-Edison (French and English), Khotinsky, Cruto, Allgemeine, Hongroise, Zurich, Gerard, and Siemens. Several of the nominal 16-c.p. lamps gave an average of 8 c.p., 12 c.p., or 13 c.p. The best result seems to have been obtained with a "Gabriel" of nominal 16 c.p., which started at 18 and ended at 14·98 (average 16 c.p.), after burning 1,800 hours. This lamp took 63 watts. The English Edison-Swan came next with a start of 18·4, ending at 13·9 (average 16 c.p.), 60 watts, lasting 1,200 hours. The Hongroise nominal 16-c.p. started at 21 c.p. and dropped to 13·25, using 62·5 watts for 1,250 hours. The Allgemeine 16-c.p. lamp only started at 15 c.p., and dropped to 12 c.p., lasting 1,000 hours, but then it only took 50 watts. Other types took even less and died in 600 hours. The article is very interesting from both manufacturers' and consumers' points of view, and is worth further attention.

Workshop Lectures.—The following syllabus of a set of workshop lectures which are being given week by week at Messrs. Blakey, Emmott, and Co.'s works by Mr. J. H. Rider, M.I.E.E., will be found interesting. The course comprises lectures on Current and its Measurement, Galvanometers, E.M.F., Difference of Potentials and their Measurement, Resistance and its Measurement, Batteries—Primary and Secondary, Insulation, Quantity and Capacity, Commercial Ampere and Voltmeters, Electric Power and its Measurement, Induction, Arc Lamps and their Mechanism, Continuous-Current Dynamos and Motors, Alternating-Current Dynamos, Transformers, Alternating-Current Motors, Conductors, Electric Transmission of Energy, Systems of Distribution, Central Stations. The lectures extend from January to December. The following are the conditions: The lectures will be given at the works, on Tuesday evenings, from 7.45 p.m. to 9 p.m.; the lectures will be open to all the articled apprentices of the firm, who will be expected to be regular and punctua in their attendance; all attending must provide themselves with a suitable note-book; questions may be asked at the close of each lecture, but they must refer only to the subject-matter of the lecture or previous ones.

Khotinsky Lamps.—M. D. Angé, of the Khotinsky Company, has published the result of some interesting experiments he has made on the relative advantage of different efficiencies of incandescent lamps. From these it would appear that it is not improbable in the future that lamps at 1·5 and 2 watts per candle might be used with economy. In the ordinary lamps 1·5 watts per candle will only give 55 hours' life, 2 watts 90 hours, and 2·5 watts 150 hours. But the following lives are guaranteed by the Khotinsky Company:

Initial consumption.	Average life.
1·5 watts per candle	250 hours.
2·0 " "	350 "
2·5 " "	500 "
3·0 " "	700 "
3·5 " "	1,000 "
4·0 " "	1,200 "
4·5 " "	1,500 "
5·0 " "	2,000 "

The Khotinsky Company have been able to obtain this relative long life in the lamps of 1½ and 2 watts per candle by the use of a "protector" to prevent the formation of the blue arc, which generally begins to show, when overrun, between the filaments. Consumers will wish to know if these figures can be maintained in practice, and in what degree the light falls off at the end of the time mentioned.

Electricity in Agriculture.—The employment of the artificial light of arc lamps for forcing plants and vegetables seems likely to be eventually adopted on a commercial scale, when the results of continued experiments that are being constantly carried out are made more widely known amongst those interested. The French are proverbially known as masters of careful husbandry on small plots, and in the direction of this *petite culture* by electric light they have already secured good results. Experiments have been carried on for some time back at the central markets, and the results have been communicated to the Académie des Sciences. The plants under observation were divided into three classes. One set was subjected continuously, night and day, to the full blaze of the electric light; the second set was kept alternately 12 hours under the artificial illumination and 12 hours in perfect darkness; while the third set was left for the purposes of comparison to the ordinary natural course of daylight and darkness alone. The conditions in regard to heat, moisture, and so forth were kept identical in all three categories. The result showed that the plants which were kept continuously under the electric light advanced in growth and retained their freshness in a very surprising manner, but their tissues were weak, flabby, and imperfectly developed. In the other two test cases, however, very little difference was observable between the sets of plants which had 12 hours' light and 12 hours' darkness, though the light in the one instance was natural and in the other artificial. The outcome of the experiment serves to show that plants thrive best with periods of alternating light and darkness, and that electric light for this purpose serves as well as the sun's rays.

Technical Schools.—Great activity is being manifested all over the country to give the full advantage of the technical education grants. A technical school was opened at Bath by the mayor last Friday, which is eventually to be housed in one of the new wings of the Guildhall. Mr. Day

is the director. At Ashton-under-Lyne new technical schools were opened this week at a cost of £16,000, of which £10,000 was given by the late Mr. G. Heginbottom The council includes representatives of most of the educational bodies in the town. A great feature is made of the chemical laboratory. The foundation for a new technical school for Salford was laid on Saturday, estimated to cost £50,000. Provision will be made for the teaching of physics, mechanics, engineering, and the handicrafts associated with it — joinery, turnery, wood working, plumbing, building construction, drawing, modelling, painting, spinning, weaving, dyeing, cookery, and some of the minor industries of the district. In the various class and lecture rooms there will be accommodation for 2,000 students. Commodious dining-rooms, dayrooms, and library will be provided for the use of the students, and suitable rooms for the teachers, committees, and secretaries. Behind the main building there is to be a large room, capable of seating about 600, for popular scientific lectures and entertainments, and for musical performances. At Stonehouse, the technical school has been enlarged and a large amount of scientific apparatus obtained, and tools and benches are being obtained. The Holland (Lincolnshire) County Council intend to appoint an administrative secretary, and active work is proceeding. At Richmond-on-Thames a new technical school will be erected, half-way up Richmond hill, on a new estate

Huddersfield.—The central station buildings at Huddersfield are not in nearly such a forward state as was hoped would be the case by this time of the year. A strike of masons intervened, and spoiled two of the best summer months. However, the masons are now at work again with a halfpenny out of the penny they struck for, and the buildings are gradually being brought into shape. The chimney shaft is half-way up, and the walls of boiler and dynamo houses are rising. Mr. A. B. Mountain, the Corporation electrical engineer, has his office in some old houses close by, and is doing his best to push things forward. The machinery has been ready at the Brush Company's works for some months. The mains also are mostly laid. The Callender Company have these in hand, and a new method of laying conduits has been used for the mains. Instead of solid bitumen jointed to form conduits, paper tubes are first laid in iron troughs and the melted bitumen is poured in solid around these tubes. This makes a very smooth and neat conduit, with no rough interstices, and the method is regarded as very successful. The station is only for a few thousand lamps at first, but it is expected by next winter an extension will be needed. No public lighting is to be done at present, at least, on any large scale, as the price of gas is so low, 10d. a 1,000 cubic feet, that it would cost three times the present charge for gas to light by electric light. A few arc lamps will, however, be placed in the squares, and at the intersections of the principal streets in the centre of the town. The central station, which is situated on Corporation land alongside the gas works, looks as if it were going to be a thoroughly satisfactory station, and the prospective demand is good, the Corporation having already wired the town offices, and the Huddersfield Technical College is to follow shortly.

Cables.—What kind of cable to specify and what insulation to use is a question which very often comes before consulting engineers and contractors, and as often as not is solved by specifying "Silvertown 600 megohm series, class S or K" for wire or cable as the case may be Of course if lead covered, for ship work, for high tension work, for concentric cables, other classes must be used, up to 5,000 megohms. For ship work it is still apparently doubtful how high a class should be used. One firm of good repute always uses 2,000-megohm conductors, and another equally good uses 800-megohm wires, maintaining that the leak in fittings is always too much for the difference in wire at 65 or 100 volts to make itself felt. However that may be, if wire is to be bought in England to-day, one certainly cannot go without the Silvertown catalogue, the subject of these remarks, a new edition of which is now before us. The list is divided into two parts—vulcanised and unvulcanised insulation. For ordinary installation work, the 300 and 600 megohm series are suitable, and can be highly recommended from long experience by most of our best electrical engineers. The Silvertown Company take immense pains to get the best results, all vulcanised wires and cables being subjected, in the course of manufacture, to a temperature considerably over 200deg F., and they can be relied upon to stand satisfactorily even at that temperature, an occasion which is rare enough. The conductors are all tested in water with an E.M.F of 500 volts after immersion at 60deg. F. for at least 24 hours, such long immersion and high-pressure test being sufficient to break down all incipient faults. A certificate of the test is given with every length of over 110 yards of the vulcanised wire and cables. This certificate should be attached—"See that you get it." The prices, number, size and weight of the Silvertown wires and cables are all fully given in the catalogue, No. 40 H, which no self-respecting electrical engineer of to-day can afford to be without.

Mill Lighting.—Mr. Jas. Gibson, electrical engineer, of Kilmarnock, has taken up our suggestion to furnish the *Belfast News Letter* with particulars and figures as to the cost of electric lighting. We abstract his figures as follows For isolated plant, dynamo driven by mill engine, the cost of a 500-light installation would be about £700; cost of upkeep, 5 per cent. interest and 5 per cent. depreciation, is ample. If driven from mill engine, the attendance is practically nil; cost of power should not be more than 3lb of coal per horse-power (of 10 lamps 16 c.p.); renewal of lamps lasting 1,200 hours is 3s. 9d. each. Assuming that 500 hours' lighting are required, we have interest £35, depreciation £35, coal at, say, 15s. per ton, £23, renewal of lamps £39—total, £132. The equivalent of gas would be considerably more. If the lighting hours are 1,000 per annum, the relative cost would be considerably reduced The longer the process, the more advantageous is the electric light. As to central station lighting, the prices charged by the various central stations throughout the country range from 8d. down to 4½d. per unit (are 16 c.p lamp for 16 hours), I believe, at Newcastle. The cost of fitting the light in private houses and shops runs from 25s per light. From the above it will be seen each 16-c.p. lamp costs fully ½d. per hour, even at 4½d. per unit. No one need expect to have the light from a central supply at the same price as gas in large towns at present, but its many advantages must more than compensate for its extra cost. Although its cost is greater, it will in many cases pay to use it, without considering its advantages from a sanitary point of view. All know the great havoc played by gas on the decorations of houses and shops, and many tradesmen find their goods considerably reduced in value from this cause The utility of the electric motor for tradesmen will also prove very considerable. Mr. Gibson's letter has been well received. Belfast is evidently anxious to have publicly and privately all information possible on the subject of the new illuminant.

Electro-Therapeutics.—It is perfectly evident that there is a definite intention on the part of the Medical Battery Company, or, as it is better known, Mr. Harness,

to fight to the bitter end for the value of his now widely-exploited electropathic belt. Our contemporary *Trade, Finance, and Recreation* seems to have taken up the cudgels on behalf of Mr. Harness. We believe, however, that such sentences as the following are unwarranted by any fact or facts that can be put forward. The sentence we refer to is as follows: "With regard to the currents generated by Mr. Harness's electropathic belts, they approximate closely in strength with natural currents, and as the belts may be joined up in any way which may be desired, they should, when intelligently arranged and applied, be productive of the most beneficial results." We cannot very well come to the final results of the author's experiments because they will not be known until next week, when the article is to be completed, but so far as we can gather from what we have before us there is nothing to connect the experiments, with an electropathic belt. In themselves, no doubt, the experiments described are exceedingly interesting. They seem to be directed to prove that the direction of current varies according to the amount of skin contact of the hand with the conductors attached to the galvanometer. For example, as described, the conductors attached to the galvanometers were composed of copper insulated with paraffin wax, and that the person experimented upon made contact on both plates with fingers and ball of thumb. In six cases out of seven a negative deflection was obtained. When, however, say, the ball of the thumb of the left hand was taken up, leaving contact only with the fingers, the deflection in six cases out of seven was positive. It would be interesting to know if the exception in each case is a left-handed man. Whether further experiments—or rather further consideration—by the author will not give a very simple explanation of these results, or if he will still contend "that the arms conduct as the two plates of a condenser conduct," must be left to the remainder of his paper; at any rate he has nowhere as yet given the slightest indication of how he connects his experimental results with any remedial efficacy of the electropathic belts.

Queensland.—On Wednesday a deputation of business men waited upon the Hon. W. Horatio Wilson to discuss the question of telegraph rates to Queensland. The deputation was very influential and put the whole question very fairly. Briefly it comes to this, that certain Australian colonies combined to guarantee the loss to the telegraph companies providing they reduced the rate per word. Queensland held aloof from this combination. We are a little indisposed to imagine, however, that the senders of messages have not been somewhat equal to the occasion. The tariff to Queensland is 9s. 5d. per word, while the tariff to the other Australian colonies is now but a little over 4s., and under the proposed fresh agreement will be 4s. 9d. We fancy that a large number of houses who have branches in Australia have branches elsewhere than in Queensland, and would telegraph their messages to the cheapest branch, and transmit by land. However, with this we have nothing to do. It is understood that if the agreement at the rate of 4s. 9d. per word comes into effect, the loss will be something like £8,000 per year under existing circumstances, so that if Queensland entered into the combination her part would be about £800. We have all along contended that the telegraph companies have by far the better part of this bargain, and that if they liked there would be no reason for any guarantee, and they could make an excellent thing out of it at even 4s. per word—or, at the outside, 4s. 6d. The tactics of the cable companies connected with Australia have been excellent from their point of view, and from the figures they provide not exorbitant. The position of the cable companies is easily defined. They have a certain capital upon which they want to pay dividends. Their working expenses must also be paid, cables maintained in efficient working order, and a sum annually laid by to replace cables when worn out; but, of course, business men have little or nothing to do with the *finesse* of Government and cable companies. What they look for is to obtain the cheapest possible rate, and if they thought they could do that by bringing pressure to bear upon the Government, they would bring pressure to bear upon the Government. If they thought they could do it by bringing pressure to bear upon the companies, they would bring pressure to bear upon the companies. From the remarks made by the Hon. W. H. Wilson, he seemed to think that the deputation made out a very strong case, and promised to communicate with his colleagues the views that had been expressed, and to do everything in his power to further the object in view.

Overhead Conductor Tramways.—One of the most successful electric railways in America is that between St. Paul and Minneapolis. These two rival towns, numbering each about 350,000 inhabitants, are situated about 10 miles apart. There are, in all, about 217 miles of tramway in the two cities, and a car runs between them every six minutes, giving a splendid service, always crowded, all day and night, save in the morning from 2 to 5 a.m. The fare is 2½d. in each city, and fivepence between the towns. The speed is from five to eight miles an hour along the streets, and up to 15 miles an hour in the open. The whole of the system is worked by overhead conductors by electricity, except 20 miles of cable in St. Paul's shortly to be changed. The gradients are severe, several of 1 in 20 and a few of 1 in 12½. A correspondent of the *Scotsman* who has recently visited this system of electric street railways, says: "I stated publicly some months ago that the overhead system was the only one now practicable. Others who had, no doubt, means of information far superior to those at my disposal scoffed at the assertion. The persons at the head of the business here assure me that the day is far distant when practically any other system of electrical propulsion of street cars will be possible. The loss in storing electricity in accumulators is excessive. The difficulty of conducting the necessary current underground is almost insuperable. The ugliness of the overhead system is, in my opinion, very much exaggerated. It is no uglier to our eyes than the rows of street lamps were to the eyes of our forefathers, who deplored the picturesque effect of the hanging lanterns so convenient and accessible in 1790. Here the lighting and the tramways are separate properties, and if they were not, the central pillars would be utilised for the electric lamps, and the effect would be just the same as in the boulevards at Paris. The rate of five cents is considered cheap here. I think it is dear. The wages of the men employed is about 17 cents per hour. They work generally 12 hours. The work is not heavy. With us we should require to have a zone system based on a uniform penny rate, with as wide a zone as possible. If we want a rapid, safe, cleanly, and cheap system of tramway accommodation in Edinburgh extending to places like Roslin, Queensferry, Dalkeith, we must be content to accept it with its attendant drawbacks. If we prefer to let posterity enjoy the advantages, we shall wait for accumulators to save the disfigurement of such lovely scenery as abounds in Leith-walk and the bridges. In places like Princes'-street it would be possible at some sacrifice to convey the wires underground."

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

(Continued from page 327.)

III.—WORK AND HORSE-POWER.

It may not be out of place to make a few remarks and give some practical examples respecting Energy, Force, Power, and Work. These four terms are often used synonymously and applied in a loose manner.

Force may be defined as "that which moves or tends to move matter." When a mass of matter is lying at rest it requires some force to start it, or to overcome its resistance to motion, this resistance to motion is called the inertia of the mass. The weight of a mass of matter is merely the force of gravity acting on it, so if you hold a stone in your hand its weight signifies that the gravitating force of the earth is pulling at the stone, striving to drag it down to the centre of the earth, and the muscular force you have to exert is spent in balancing the force of gravity. The greater the mass is, the greater is the force of gravitation acting on it, consequently its weight is greater. If there were no such thing as gravity, matter would have no weight, and, owing to the enormous centrifugal force due to the revolution of the earth, everything on its surface would tend to fly off into space.

Every particle or mass of matter exerts an attractive force upon every other particle or mass of matter, so that two bodies have a mutual attraction. The amount of attraction a body possesses is in proportion to its mass, and the mutual attraction of two bodies is in inverse proportion to the square of the distance between them—that is to say, two bodies 6in. apart are attracted to each other by four times the force by which they are attracted when at 12in. apart. We have every reason to believe that this law holds true in our planetary system, and throughout interstellar space. It is due probably to this theory that the earth is kept at a definite distance from the sun when revolving round it, and that all the planets have their fixed course. So when a mass of lead falls to the earth it signifies that the lead and the earth, following the law of mutual attraction, attract each other with a force proportional to their size, and inversely proportional to the square of the distance between them; but since the mass of the lead weight is infinitesimal as compared with that of the earth, therefore it follows that the force the lead exerts is comparatively nothing to the force the earth exerts, and the result is the lead travels all the distance, and the earth so little that it cannot be perceived.

Fundamental Units.—The French system of measuring quantities is the most simple and beautiful invention that can be imagined. It is greatly to be regretted that this method of measurement is not adopted in England by practical engineers, and that it is not used in workshop practice here. In no branch of science can it be appreciated so much as in that relating to electricity and magnetism. The British workman still plods on, using the clumsy and unscientific foot and pound, whose use causes a vast amount of brain work and valuable time to be wasted, when both could be saved were they to think and make calculations in the French units. Taking the one example of length. The foot is the British unit of length for engineers, other dimensions are the mile, yard, etc. To express miles in inches, your practical man has to multiply out on a piece of paper the expression $1,760 \times 3 \times 12$. Now examine the French unit of length—namely, the "metre"—this corresponds to the English yard, its equivalent being 39·39in., or nearly $\frac{1}{10}$th more than the yard. For great lengths, the French use the "kilometre," or 1,000 metres, and so this may be said to correspond with the mile, whilst for short measurements they have the "centimetre," or $\frac{1}{100}$th part of a metre, and this corresponds to the inch, there being 2·54 centimetres in 1in., or one centimetre = $\frac{2}{5}$in. From this it is seen that all dimensions of length are expressed in multiples of the figure 10. Thus a kilometre is reduced to centimetres by multiplying by 100,000, because there are 1,000 metres in the kilometre, and 100 centimetres in one metre. 100,000 can, however, be written in a much simpler and quicker manner by expressing the number in powers of 10, thus 10 can be written 10^1, because there is only one 10, and 100 can be written 10^2, because it signifies two tens multiplied together, or 10×10, similarly $1,000 = 10^3$, and $100,000 = 10^5$, so that one kilometre can be expressed in centimetres by the simple expression 10^5. It is the same with the units of weight. The British units are tons, hundredweights, stones, quarters, pounds, ounces, pennyweights, grains—an array sufficient to drive anyone to despair. Who does not remember the mental torture of committing to memory those weights and measures tables of our juvenile school days? To express tons in ounces, we must multiply out the lengthy expression of $20 \times 112 \times 16$. The French unit of weight is the "gramme," and 454½ grammes go to the English pound. The kilogramme signifies 1,000 grammes, and corresponds to the pound, its value being 2·2lb. The milligramme signifies $\frac{1}{1000}$th part of a gramme, and all these weights are expressed in multiples of 10, same as with the various lengths. One kilogramme = 1,000,000 milligrammes, or 10 milligrammes. The above instances are only two out of a number that could be quoted to prove how barbarous and ridiculous our units of measurement are. Knowledge is quite hard enough to acquire without making its acquirement doubly laborious, units and standards are merely arbitrary and used as vehicles to convey our thoughts in drawing comparisons, and they should be the slaves of man instead of man being their slave, as he often is.

Length, Weight, and Time are the three fundamental quantities, and in the French system the centimetre is taken as the unit of length, the gramme as the unit of weight, and the second as the unit of time—the symbol letters C G S being used to denote respectively the centimetre, the gramme, and the second. Hence the system is known universally amongst scientists as the C G S system of absolute units. Unfortunately, this system is so little known in England that it would perhaps be better to express mechanical calculations in foot pounds, since these units are known to everyone, whilst the others are only known to a few.

The Unit of Force is named the "dyne," and it is that amount of force which acting for one second, when applied to a mass of one gramme weight, will move it through a distance of one centimetre in one second of time. This force is expended in overcoming the resisting force of the mass through a distance, and when this is effected, it is said that *work is done* upon the mass. When a mass is lifted up vertically, work is done upon or absorbed by the mass, since the resisting force of gravity is overcome through a certain distance.

The Unit of Work is named the "erg," and it signifies the work done in overcoming a resisting force of one dyne through a distance of one centimetre. Now if a mass of matter weighing one gramme be allowed to fall freely, it would be seen that, owing to the force of gravity acting upon it, it would fall a distance of 981 centimetres in one second of time, hence the force of gravity equals 981 dynes, so when one gramme of matter is lifted vertically through a distance of one centimetre it is evident that a force of 981 dyne must be overcome through a distance of one centimetre; consequently, 981 units of work must be spent on the mass to raise it that distance.

Energy is an expression that denotes the capability of a body to do work. All moving bodies possess energy, usually termed stored energy, thus, a moving railway train has a vast amount of stored energy in it, and so has a revolving wheel. It has been shown that an expenditure of 981 ergs is necessary to raise one gramme through a vertical distance of one centimetre. It may be thought that this amount of energy is wasted, but this is not so, for we have the law of the conservation of energy to deal with, and the energy is absorbed by the weight and can be recovered, for let the weight fall back to its original position, in the act of falling it will develop energy, and do work, and the work done by it will be exactly equal to the work done upon it; so that a body can have two kinds of stored energy in it, one kind when in motion and the other kind when at rest. All

bodies at rest possess "potential energy," in virtue of the position they occupy, as compared with bodies at a lower level. A boulder on the top of a lofty mountain possesses a great amount of potential energy because falling to the plains below it could develop, by virtue of its elevated position, great energy. A boulder on the plains possesses an amount of potential energy measurable by the distance it can fall. From this it can be understood that the potential energy of a body decreases as it gets nearer to the centre of the earth, and if it were possible for a body to be situated exactly in the centre its potential energy would be zero. Kinetic energy, on the other hand, is the energy that is developed by the moving or falling body. A stone just at the moment of falling possesses nothing but potential energy, so that its potential energy is a maximum and its kinetic energy a minimum, or zero; whilst falling, the potential energy changes into kinetic, half-way down its energy is half potential and half kinetic, and at the moment of striking the ground its kinetic energy, or developed capability of doing work, is a maximum, while its potential energy is at zero, the potential thus becoming converted entirely into kinetic (so far as concerns the potential energy due to the difference between the two levels).

Work can be expressed as the product of two factors, weight and distance; and however the values of the factors change, provided the product is the same, the work done is the same. Thus, 50 grammes raised 100 centimetres requires as much work as 100 grammes raised 50 centimetres, or 1,000 grammes raised five centimetres.

Power means the rate of doing work or the amount of work that can be done in a certain time.

The unit of power is named the "watt," and signifies work done at the rate of 10,000,000 ergs per second; this is the practical unit, because the absolute unit of power, which signifies one erg per second, is far too small to be of any practical value. It was shown that it required 981 ergs to raise one gramme a distance of one centimetre, and as one watt equals 10,000,000, or 10^7 ergs per second, therefore (using 1,000 for 981 for simplicity) it will raise $\frac{10^7}{10^3} = 10^4$ grammes a distance of one centimetre in one second, or 10 kilogrammes a distance of one centimetre.

One kilogramme equals 2·2 English pounds.
One centimetre ,, ·4in. (nearly).

and 2·2lb. raised ·4in. is equivalent to nearly ¾lb. raised 1ft. high. So in English units one watt signifies work done at the rate of lifting ¾lb. a distance of 1ft. in one second (approximately).

The watt is adopted as the unit of electrical power, and will be further considered in this respect when treating of electrical units. For mechanical powers the unit of power in England is the horse-power; and expressed in units of pounds, feet, and minutes, it is equivalent to 33,000lb. raised 1ft. in a space of one minute—that is, 33,000 foot-pounds per minute; and this number was fixed upon because it was reckoned that a very strong dray-horse could do that work, but if it could, it could only keep up this rate of work for a very short time, say, a few minutes, so that the average power of a good horse, working all day, is far less than the standard given, in all probability not much more than 20,000 foot-pounds per minute. 33,000 foot-pounds per minute = 550 foot-pounds per second, and 550 ÷ ·737 = 746, so that 746 watts go to the horse-power.

There are three different kinds of horse-power used when expressing the power of a steam engine: Nominal, Indicated, and Brake. Concerning the first—namely, that of nominal the less said the better, the word is simply used by makers of steam engines and boilers to express size, and gives no information respecting the power of a machine. Some makers say that their nominal can be taken to signify 2½ times the indicated, others three times; others, again, twice; others still something else. It is a wretched term, absolutely useless, and a cause of considerable annoyance; an undefined term like this always has a suspicious appearance. The disease, unfortunately, has seized hold of electrical apparatus; thus we have arc lamps of *nominal* candle-power, and the trusting purchaser either finds out, or does not find out (according to his knowledge or ignorance) that the actual candle-power is probably one-half of the nominal. The word "nominal," when applied in this misleading way is deceptive in the sight of every right-minded engineer.

Indicated horse-power signifies the rate of work done by the piston, and so is a measure of the power developed by the engine. Brake horse-power signifies the power that is given right off the driving wheel, and evidently this measure is the best and fairest, because it represents the actual useful power given by the engine. The brake is necessarily less than the indicated, since the difference between the two measures the loss due to the friction, etc., of the moving parts, and this loss differs a great deal in various engines, according to whether they are well designed or not; it also differs according to the size of the engine. For example, a large sized engine may have its brake 12 per cent. lower than its indicated, while in small engines it may be 20 per cent. or more.

How to Calculate Indicated Horse-power.—This is done in the following way. Multiply the pressure of steam in pounds per square inch by the area of the piston in square inches; this gives the total force acting on the piston. Now multiply this by the distance in feet through which the piston moves, or the length of stroke, as it is termed, but since the piston must make a forward and backward stroke in order to produce one complete revolution of the driving wheel, hence the length in feet must be multiplied by 2. We have now obtained the product of a force acting through a distance, which signifies work done in foot-pounds; and to obtain the power, or rate of doing work, we must finally multiply by the number of revolutions per minute that the driving wheel makes. This gives the number of foot-pounds moved in the space of one minute, and when the rate of doing work is such that 33,000 foot-pounds of work are done in one minute, then 1 h.p. is produced, so we have now to divide the total product by 33,000. The result gives the horse-power.

This rule may be expressed in the following formula:

$$\frac{P\,L\,A\,N}{33{,}000} = 1 \text{ h.p.}$$

P = pressure of steam in pounds per square inch.
L = length of stroke of the piston in feet, multiplied by 2.
A = area of the piston in square inches.
N = number of revolutions per minute of driving wheel.

Here the three fundamental units of weight, length, and time are represented.

1. Pressure representing the weight in pounds.
2. Stroke ,, ,, length in feet.
3. Revolutions ,, ,, time in minutes.

The following example shows how to apply the above: The cylinder of a simple engine is 9in. in diameter, its length 12in., speed is 200 revolutions per minute, and steam pressure 80lb. per square inch. Find its indicated horse-power.

ON THE MANUFACTURE OF INCANDESCENT ELECTRIC LAMPS.

BY FREDERICK GRAHAM ANSELL, F.C.S.

(Concluded from page 328.)

I have now described a complete process for making an electric incandescent lamp, and have in one or two instances given a brief outline of an alternative process for doing certain parts of the work, but there are several other matters which should also be mentioned, consequently I add this appendix, although what I have previously said should be ample to enable anyone with a little knowledge of electricity to make a complete lamp.

In the first place, I must mention that several dipping solutions have been tried and patented, but none of them are improvements upon the sulphuric acid solution mentioned in the text. There is a beautiful blue solution

known as cuprum ammoniatum, or ammoniated copper, made either by adding strong liquid ammonia to a concentrated solution of sulphate of copper, or by standing bright copper turnings in strong ammonia solution. This solution is used by the Willesden Paper Company in preparing their valuable papers for various purposes. It gives very good results. There was also a patent for preparing the filaments by means of a strong acid solution of sulphate of zinc. All I know of this is that the lamps supposed to be made by it are never heard of now. With regard to Swan's patent for preparing filaments by dissolving gun cotton in ether, etc., as mentioned in the early part of the text, it appears to me that the chief advantage to be derived from this is that the cross-section of the filament may be made any desired shape, while at the same time its homogeneity is assured. The shape of the cross-section is not altogether a matter of indifference in designing a filament, because, although a circular form gives the greatest mechanical strength, it at the same time encloses the greatest amount of material in the smallest possible surface; and as only the surface emits light, although the whole mass has to be raised to incandescence, it necessarily follows that with a round-section filament we are doing maximum work to obtain minimum light, because if we could flatten the filament we should have much more of its substance exposed, or, in other words, we should get more luminous surface but at the expense of mechanical strength. It is also possible to flatten cotton prepared by the sulphuric acid process a little, but not to anything like the extent possible in Swan's process. I need hardly mention that the length of the filament is not a matter of indifference in designing a lamp, as, other conditions remaining equal, the longer the filament the greater the candle-power of the lamp. The only way to ascertain the amount of light given by a lamp (its candle-power) is by a photometer, and the simplest and easiest of these is perhaps that known as Bunsen's. It consists of a straight horizontal rod about 12ft. long, graduated in inches, with the usual smaller fractional parts, such as the quarter or one-eighth, accurately marked. At one end of the rod is a candle burning 120 grains of wax per hour, and with a nice, small, evenly plaited wick, while at the other end is the electric lamp burning under its proper conditions. Between the two is a light movable frame capable of standing by means of clamps or feet on the graduated rod, and holding vertically a sheet of clean white note-paper, or white tissue-paper evenly extended, so that its surfaces shall be at right angles to the rays of light coming from the candle, and also to those coming from the electric lamp. In the middle of the paper a spot of grease—say, oil—is put; this is best done before the paper is mounted in its frame, as then it can be held horizontally and a drop of oil allowed to fall on to it. To use this instrument, the frame and its paper is moved along the rod in the required direction until it is no longer possible to discern the grease spot. The distance between the paper and the candle is accurately noted, also that between the paper and the lamp—each distance is multiplied by itself, or squared, as mathematicians say, and the smaller divided into the larger, when the quotient is the candle power of the lamp.

Next, as to the "paste" used for fastening the filament to the platinum leading-in wires. Distilled water should be used in mixing this, because ordinary water contains lime and other chemical bodies, such as carbonates and sulphates, which are easily decomposed by contact with hot carbon, and which contain oxygen, the worst enemy of the filament; in fact, the only object of the elaborate and troublesome process of exhausting the air from the globe is to keep oxygen from the filament, because oxygen has the power of combining with carbon and converting it into invisible, but poisonous, gases—namely, carbonic acid and carbonic oxide. Further, the decomposition of the chemical salts contained in the water would also tend to disintegrate the filament, besides effecting the destruction of it as above, but I need not trouble you with chemical formulæ, as it is sufficient to say that the carbon should be kept as pure as possible, and that no amount of exhaustion by the air pump could possibly get the combined oxygen from any of the salts contained in water.

The drying chamber, D, of the air pump, Fig. 6, may contain concentrated sulphuric acid with a few small lumps of pumice stone, or powdered anhydrous phosphoric acid, or fused chlorides of calcium; but this chamber is really more trouble than it is worth, so I should dispense with it entirely, more especially as I have found by experience that there is no great need of it. While on the subject of the air pump I will just mention that there appears to be no reason why it should not be made of iron throughout, provided that the inside of every tube should be quite smooth, like a gun barrel. The joints could be made perfectly airtight with very little trouble and the use of red lead, and a piece of glass tube could be put in for a gauge, to show how the vacuum is if thought advisable, and also a piece of glass tube could be joined on perfectly airtight from C to K, so that the lamps might still be put on for exhaustion, as already suggested. With those iron tubes a gauge glass parallel with G G would certainly be desirable. The great advantage of the iron pump would be its superior strength, for, as already stated, the glass tubes are constantly breaking, and this in a large factory becomes a serious nuisance. Whether made of glass or iron, the pump should be carefully attached to a piece of board to keep it in its proper shape and position, for the weight of the mercury in the various parts when the pump is at work is very considerable. So far as at present described, the pump, Fig. 6, should be terminated at K, but as the exhaustion is rather a long operation, it might be advisable to use some form of quick acting mechanical pump to obtain a fair vacuum of, say, about 28in. of mercury to start with; and if this were done, some such arrangement as that depicted at K M N would be necessary, N being a small movable cistern attached to the U tube, K M, by means of a flexible indiarubber tube, as shown at A B C D in Fig. 5. The mechanical arrangement would then be connected at M.

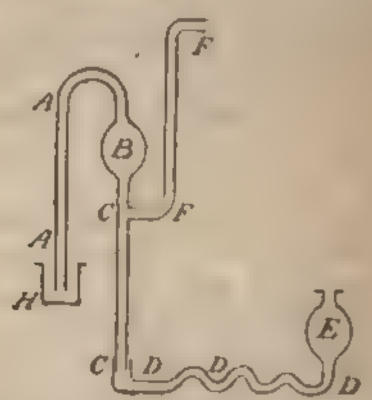


FIG. 7.

Instead, however, of a plunger or mechanical air pump, there is another form of mercurial air pump which is very simple, fairly expeditious, and easily managed. It was used by Lane Fox in his early experiments, and is capable of giving a good vacuum of 30in., whereas a plunger air pump will not give more than 28in. The pump is best made as in Fig. 7, where A is a tube bent over, as shown, and dropping down at least 33in. or 36in. into a vessel of mercury, H, where the air escapes; B is a somewhat capacious vessel between the tubes A and C. At the bottom of C is a flexible tube leading to a cistern, E, which can be raised and lowered at will. The vessel to be exhausted is attached to the upper end of the tube, F, which must be at least 33in. in length in its vertical part.

The vessel, E, must always be raised gently, or else the mercury will run over the top of F when the vacuum becomes good. All corners should be avoided in the tubes A, C, and F, as also in the vessel, B. This pump may be made of glass, or smooth-bore iron tube. It is well, in arranging both this and Sprengel's air pump, Fig. 6, to arrange the lamp, or any vessel to be exhausted, so that the air it contains at starting may be able to fall or flow out easily, and not to connect it to the pump, so that its contained air must pass out at the top, for in the latter case a perfect vacuum becomes an impossibility.

The principal object in "flashing" is to make the sectional area of the carbon filament uniform throughout its

entire length, as any part being thinner than the rest would, of course, become hotter under the action of the electric current, and it would therefore get a more abundant deposition of carbon from the benzene or gas, as the case may be, whilst any thicker parts being cooler would not get so much in the same time. Consequently the filament, if uneven before flashing, is even after. Flashing also coats the filament with a hard, compact form of carbon, and makes it more durable and more efficient. It is often found that the resistance of the finished lamp is not quite identical with that of the filament at flashing. The filament should never be flashed in its own bulb or globe, but always in a somewhat larger vessel, as suggested in Fig. 4, because the decomposition of the hydrocarbon vapour produces a heavy, oily substance which coats the inside of the flashing vessel and would obstruct the light, thus reducing the efficiency of the finished lamp. Glass is suggested in Fig. 4 to enable the action to be easily observed and understood, but in actual practice an iron vessel would be preferable, and it should be arranged to screw on to its place or bottom plate perfectly airtight. If it is made simply to lie on a plate as an ordinary air-pump receiver, difficulty will be found in removing it after each operation, and this will lead to the breakage of many filaments, unless special protecting studs could be used.

It has been suggested that certain refractory bodies might be incorporated in the carbon of the filament made by Swan's process of dissolved nitro-cellulose, etc., but owing to the danger of chemical reaction between these bodies and the white-hot carbon, and also owing to the unequal expansion and contraction they would cause in the filament when lit and extinguished, this idea had to be entirely abandoned in favour of the purest carbon which can be obtained.

It is worthy of note that the resistance of a filament cold is about double its resistance when hot, and that the work required per candle-power is about four watts for 16 or 20 candle lamps. This figure, however, does not hold good for lamps of much larger or of much smaller candle-power, nor is it exactly true for lamps which are not well designed, or for lamps of low resistance, which require a large current. For instance, a lamp designed for 100 volts would require about ·62 ampere, while a lamp designed for, say, 50 volts, would require about 1·4 amperes. All incandescent lamps are very delicate, and consequently require great care from the person in charge of them. If subjected to a higher E.M.F than that for which they are made, their endurance will be greatly shortened, but under favourable circumstances they should give a good light about 1,000 hours. The author has, however, known several 16-candle Swan lamps to last 1,700 hours on an installation under his own charge. Some makers have claimed a higher efficiency than four watts per candle power, but this must not be too readily credited, as it is a matter of some difficulty to determine the exact candle-power of a lamp. In fact, at one time it was a custom to send out 16-candle lamps as "20-candle lamps"; and in making the test it would be very easy to claim almost any efficiency, because the amount of light emitted varies at a very rapid rate with the current when the current is anywhere the normal figure. The lamp would withstand this strain long enough to give most flattering figures, but if always subjected to the same current the strain would be too great, and so the lamp would not stand the time test, and its real efficiency would be reduced to absurdity. Mr. Preece, the electrician to the Post Office, found that the light given by a 16 candle lamp varies with the sixth power of the current when normally lit.

This treatise would hardly be complete if I omitted mention of a plan I devised in 1883 for making a then new form of filament, and which formed the subject of an agreement between a well-known electrical firm and myself. I proposed to take a wire or strip of, say, calcium, or one of the metals of the same group, and to oxidise its surface by passing a current through it just enough to make it hot. This would coat it in the case of calcium with a covering of lime, which I thought would be strong enough to keep the metallic strip or thread in its interior intact, but of course there was a doubt on this point, and a break in the continuity of the unoxidised metal would have been fatal to the lamp. It is also very possible that expansion and contraction would have been too much for my compound filament, and so the scheme was abandoned, as also one I had for coating an ordinary carbon filament with an electro-deposition of the same metal (calcium) or aluminium, or magnesium, and then oxidising it entirely; but except as a matter of history these designs are not worth mention, as they have all been abandoned in favour of pure carbon. In conclusion, a plea for our native language. Let me ask you always to say incandescent lamps, because this is more in accord with the idiom of our tongue than incandescence lamps or glow lamps.

TRANSFORMERS MADE BY THE SOCIETE L'ECLAIRAGE ELECTRIQUE.*

BY M. F. GERALDY.

The theory of alternate-current apparatus is settled satisfactorily, but the methods of calculation applied to these machines in practice are less understood than for continuous currents. The makers have their rules, but these are hardly as yet definitely embodied in practical formulæ. With regard to resistances and the heating of wires these calculations are based on what is known of continuous currents, but as regards inductive action, the preponderating effect in alternate-current apparatus, progress seems still largely to be made by the method of trial and error.

This absence of calculation produces the risk of serious errors in any departures from old forms, witness the Frankfort experiments, where the machines, built for 300 h.p., did not transmit over 120 h p.; the designers did not sufficiently allow for self-induction. Other examples might be easily given of apparatus built for certain purposes which has had to be abandoned for want of the proper facility for theoretical calculation beforehand. This uncertainty was less troublesome for generators—in some cases it was even useful. The Gramme alternator by chance gave a constant current, and thus was exactly the most favourable for driving Jablochkoff candles, for which purpose it was designed. But the disadvantages became fully apparent when alternators began to be employed as motors.

The necessity for a complete theory is making itself widely felt, and it is certain, moreover, that we shall not need to wait long. This theory is crystallising itself; we shall have only to bring together the partial studies already made to obtain a satisfactory whole.

What is true of the alternate-current dynamo is true of the transformer. We have no correct working theory known by all. We can doubtless easily give the principles of its action, but the theory so presented is only figurative, and gives little real guide in construction. On the other hand, we can establish mathematically and with exactitude the theory of the apparatus, but the theory is complicated, and it is difficult to discover therein a basis of application. Added to this is the fact that, from want of sufficient well-designed machines, we do not as yet possess the experimental data necessary for the construction of suitable apparatus for predetermined output and the best use of materials.

In the first attempts at transformer building theoretical ideas, correct in themselves, were taken, and the greatest effort was made to utilise to the utmost the mutual induction of primary and secondary circuits. With this object, Gaulard intimately mixed the circuits together, and Zipernowski enclosed his transformers in a covering of iron. It was at this period that arose the quarrel between open and closed magnetic circuits—a quarrel which is even now not completely ended. This continuance of the discussion is alone sufficient to prove that the theory of transformers is incompletely settled, for a question of this kind should be at once determined. The closed magnetic circuit seems to be the one now generally adopted, and it appears certain that the truth is in this direction: theory will eventually confirm practice.

* Translated from *Electricité*, September 15, 1892.

But in striving to fulfil the theoretical considerations, sufficient attention has not been paid to those practical considerations, the importance of which will make themselves felt in actual use. It has been easy to arrange the circuits from the point of view of resistance and heating, for it was here that the habitual calculations aided, but sufficient attention has not been paid to the heating of the iron by hysteresis, which is very considerable; on the other hand, the close juxtaposition of the two circuits at very different potentials soon showed itself to be a danger to insulation and a great difficulty in construction. The first types of transformers are therefore becoming greatly modified.

The efficiency of transformers was not difficult to calculate for normal working—that is, for full load; but it was necessary to remember that this efficiency fell considerably as the load diminished. This lowering of the efficiency at small loads is even to-day the principal defect of transformers. It has proved so serious that it has brought about an entire change of system; instead of distributing, as seemed natural and easy, as at first was done, by arranging small transformers at every point of distribution, so as to distribute entirely at high tension, the tendency is nowadays, on the contrary, to erect a small number of transformer stations and distribute at low pressure; and even in these stations means are taken, either automatic or by hand, to regulate the transformers. All this causes, for alternate-current systems, a noticeable increase of expense, and introduces serious complication.

This defect of the transformers is so general that it is willingly considered as inherent to the apparatus. If it is maintained that the efficiency will always be lower as the load decreases, this is no doubt true. But what is not true is the statement that this defect will always bring with it, for high-tension distribution, the disadvantages that have been mentioned; it is simply a question of proportion.

If the efficiency, for instance, fell from 95 per cent. at full load to 60 per cent. at quarter load, the defect is serious; if the efficiency fell only to 75 per cent., the defect is less grave; while if the lower limit was 85 per cent., it is practically insignificant. Call to mind what has happened in the construction of dynamos. At first a number of different arrangements were made to regulate the efficiency of dynamos; their voltage varied greatly with the load. The method of double winding was invented specially to correct this defect; yet nowadays it is hardly used save in certain particular cases. The machines have become so good that their loss of efficiency plays but an insignificant part.

Cannot the same result be obtained by a good construction of transformers? The figures communicated to us, which we give further on in this article, seem to show that it can.

The Société L'Eclairage Electrique, which owns the Jablochkoff candle in France, have always needed to produce and distribute alternate currents. It was natural, therefore, that they should busy themselves with the manufacture of transformers. They have established a very complete factory for this purpose, and produce three different types of transformer. The first, Fig. 1, employed for low pressures, was designed for use with the Jablochkoff candle. The magnetic circuit presents the form of a rectangle. The base is formed of plates of insulated sheet iron, the extremities of which are slotted. On this part are wound the primary and secondary bobbins, which are distinct and superposed. The circuit is closed by means of sheet iron plates curved in horseshoe shape, and introduced and punched in place in the slots prepared in the base. These small transformers can transform from 500 to about 1,000 watts. When used with Jablochkoff arc lamps they are employed one for each lamp, the distribution being generally in series on a single cable. The Gramme alternator, which has a practically constant current, lends itself well to this very convenient arrangement.

The second series goes from 1,000 to 5,000 watts; the transformers are similar to those of the third type, and it is therefore not necessary to describe them. We ought, however, to point out one detail which is, indeed, general in the transformers of the Société L'Eclairage Electrique, and is considered very important. The superposed sheets of insulated iron which form the magnetic core are not all of the same width. They are put together by successive layers of slightly different widths, as seen in Fig. 2. This arrangement establishes along the core a series of longitudinal slots, which, when the transformer is working, act as air passages, allowing the iron core to cool. This special cooling of the core is, it seems, of the greatest utility, and, as will be seen further on, still other means have been sought to obtain this cooling effect, which allows the mass of iron to be reduced, and the maximum of permeability to be employed—one of the most important elements in efficiency.

FIG. 1.

Fig. 3 shows the construction of the iron for the third series. The sheet iron is cut in rectangles and the pile is put together with cooling surfaces; from this mass a solid cylinder is cut out, as shown, leaving the legs much in the shape of dynamo magnets. On these legs are placed the primary and secondary windings, always distant and superposed, and then the cylinder is replaced, completing the magnetic circuit in a very satisfactory manner.

Still further to ensure the cooling of the iron, transformers have lately been constructed with small spaces between the core and the coils, forming air shafts in which the air circulates energetically. It has been found that in the transformers thus built a considerable difference is established during working between the temperature of the core and of the wire and their insulation, the latter remain comparatively cool, a result which ensures good preservation.

FIGS. 2 AND 3.

The transformer thus built up is drawn together tightly by means of bolted cast-iron frames, which serve at the same time as feet. The transformer then presents the appearance shown in Figs. 4 and 5.

The commercial transformers are not furnished with the numerous terminals shown in the illustrations, which represent combination transformers, constructed for the study of high pressures. These were constructed specially for the researches which are being made by M. Leblanc for the Société pour la Transmission de la Force.

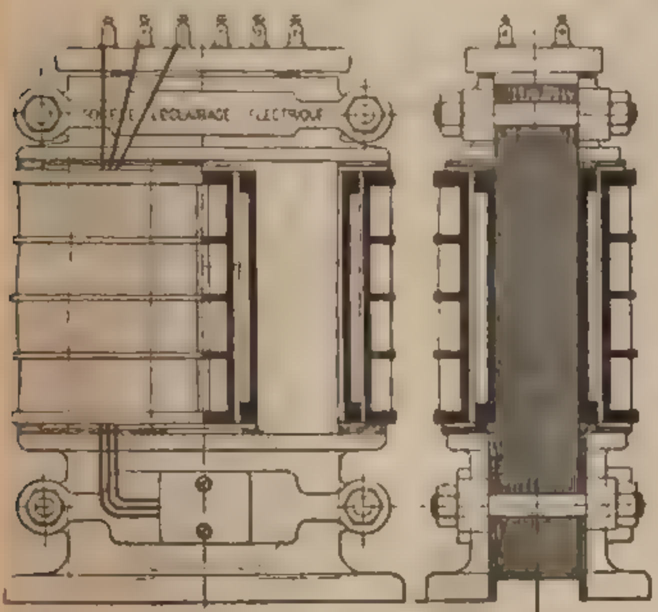
The following are the details of these transformers, furnished by the Société L'Eclairage Electrique. We take as a sample of the commercial transformers one of 15,000 watts.

The secondary circuit can generally be modified by a certain number of turns in order to obtain the exact

E.M.F. required for the mains. This model may therefore be employed for 2,400 or 2,500 volts primary, and the pressure of distributing wires can be regulated for 100 or 105 volts.

Section of primary circuit	4·52 sq. mm.
Effective strength of current, about	6·25 amp.
Density of current per sq. mm., about	1·38 amp.
Number of primary turns	720
Resistance of primary	2 ohms.
Loss of E.M.F. in work	
$r_1 i_1 = 2 \times 6{\cdot}25 = 12{\cdot}5$	½ per cent., about.
Section of iron	130 sq. cm.
Effective E.M.F. of primary	2,400 volts.
Frequency	80
Effective induction B per sq. cm.	4,440
Maximum induction	6,250
Section of secondary circuit, several wires in parallel	133 sq. mm.
Effective secondary current	150 amp.
Density of secondary current	1·13 per sq. mm.
Resistance of circuit	0·00333 ohm.
Loss of E.M.F. in work	
$r_2 i_2 = 0{\cdot}00333 \times 150 = 0{\cdot}0499$ volt, or	½ per cent.
Weight of transformer, 225 kilog.	495lb.

The variation of E.M.F. between no load and full load for a constant primary E.M.F. is about 1 per cent.



Figs. 4 and 5.

The efficiency is taken at the mean temperature of working:

88 per cent. at	⅛ full load.
90 ,,	¼ ,,
92 ,,	⅓ ,,
94 ,,	½ ,,
96 ,,	¾ ,,
97 ,,	full load.

The efficiency decreases a little after a very prolonged run at full load by reason of the heating of the copper, but as the arrangement described renders the temperature of the wire practically independent of the temperature of the iron, the transformer keeps very high values of efficiency at small loads.

The loss in running at no load is less than 2 per cent. of the total power absorbed at full load.

It will be interesting to mention the manner of testing the efficiencies. A method similar to that indicated by Hopkinson for dynamos is applied. Two similar transformers are connected up to act against each other, and the total efficiency is measured after the double transformation. The number obtained is the square of the number sought. Measurements made thus at low pressure and on quantities of the same order are easier to take and are more precise.

Special transformers have been constructed, as we have said, for the researches of MM. Lublanc et Hutin. The following are the data given of some of these transformers.

The transformers are of 5,000 watts at a frequency of 80, the effective E.M.F. being 30,000 volts. Both primary and secondary circuits are wound in sections. The following figures are with the primaries all in series, and the secondaries all in parallel:

Section of primary circuit	0·1257 sq. mm.
Current, about	0·166 amp.
Density of current	1·33 per sq. mm.
Number of turns in primary	14,470
Resistance	1,248 ohms
Loss of E.M.F. in work	
$r_1 i_1 = 0{\cdot}166 \times 1{,}248 = 207{\cdot}9$ volts, or	less than 1 per cent.
Section of iron	72 sq. cm.
Effective primary E.M.F.	30,000 volts.
Frequency	80
Effective induction per sq. cm. B	5,740
Maximum induction	8,100
Section of secondary circuit, 12,566 × 2 =	25·13 sq. mm.
Effective current	27·5 amp.
Density of current per sq. mm.	1·095 amp.
Resistance of circuit	0·026 ohm.
Loss of E.M.F. in work,	
$r_2 i_2 = 27{\cdot}5 \times 0{\cdot}026 = 0{\cdot}715$	less than ½ per cent.
Secondary E.M.F.	182 volts
Variation of E.M.F. between full and no load	about 1 per cent.

The efficiency of this transformer at full load is about 95 per cent., and at the lower load it maintains the high efficiencies of the previously mentioned transformers.

Amongst other commercial transformers constructed by the company for primary currents of very high pressure, we may notice the following, which present the principal characteristics of the other transformers.

6,000 watts, frequency 70, primary 10,000 watts.
4,000 ,, ,, 43, ,, 25,000 ,,

All these high tension transformers have been constructed for actual industrial application, and their price being not greatly different from those commonly employed, it will be readily admitted that these results promise well for the extension of double transformations with any desired pressure in the primary circuit, even for small loads. The separation of the high-tension circuit and the special precautions adopted do away with all risk of danger from these transformers. These new arrangements do not complicate the design of the transformer; on the other hand, they have been adopted, even though really not needed, in the later types of transformers for ordinary pressures.

If the transformer is immersed in oil, it is preferable that the insulation (paraffin, for instance) should only become liquid when hot, as this facilitates transport, and prevents admixture of air and dust. The liquid circulating in the spaces made in the transformer, cools itself by contact with the metal cover.

This metal cover is constructed to increase the cooling surface to the greatest possible extent. The sides are formed by a series of tubes placed vertically, or else vertical wings are arranged against the lateral sides of the cover as in well-known forms of heating apparatus for hot water and steam.

The various types of these transformers being especially for commercial use, they can bear considerable variation in the conditions of working, output, frequency, or voltage. A transformer giving 25,000 volts can stand 50,000 volts without inconvenience.

One of these types, for instance, presents the following conditions:

Capacity	1,500 watts.
Primary	10,000 volts.
Secondary	25 volts.
Frequency	9

The primary circuit is formed of 19,960 turns of a total length of about 14,000 metres. By increasing the frequency the pressure may be raised to 40,000 without inconvenience.

These transformers have uniformly given good results, although subject to rough usage. They appear to be the result of a thorough theoretical and practical study, carried much farther than has been done hitherto. The figures of the efficiency here given seem at least to justify the statements made at the commencement of this article; and it may be maintained that a distribution made under these conditions would hardly need special precautions to be economical.

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ELECTRICAL TRACTION.

Electrical traction does not cease to be one of the most attractive problems of the day. Our readers will have observed how very constantly it forms the subject of papers read before societies and of discussions and articles in the technical journals at home and abroad. Although so very little has been done in electrical traction in this country in the working on any noteworthy scale of tramway traffic by electricity, there are something like four hundred tramways worked by this means in the United States, employing nearly, it is stated, six thousand cars and about ten thousand motors, making a daily mileage of over half a million miles. The result is that necessity has forced American engineers to stick more tightly to the business of overcoming the mechanical difficulties which are encountered in the construction and working of electric motors for this very heavy work than we have done; and there is, moreover, far greater encouragement given in the form of financial aid to those who have made a fair show of mechanical success. In England we have one of the most successful electrical railways yet in operation, but the construction and equipment of electrical tramways has seldom, if ever, either commanded the attention or been placed in the hands of those engineers who are accustomed to deal with railway work. The question has not, moreover, yet taken the position which is commanded by railway enterprise or by railway finance.

A good deal of the planning and scheming of electrical tramways, electric tramway motors, and other gear have been taken in hand by the amateur and by the speculator in patents. The result has in several cases been failure, which has deterred financial enterprise in this direction. Promises have been made which have over and over again been falsified, contracts for working tram lines at a penny or two per car mile less than the cost of horse traction have under the systems adopted proved unremunerative. On all hands things have happened which have driven tramway directors back to horse traction, although there are numbers of lines in this country which only need the reduction of a penny or two per car mile to give them the new character of dividend-earning concerns. While we find that cable traction is growing in favour, and even, as at Birmingham, is earning so good a dividend that it is rumoured that the electrical line in the same town is to be converted to the cable system, the electro-mechanical system makes little or no headway.

It must, of course, be admitted that one great reason for this delay is the general objection in this country to overhead conductors; but even where the permission has been granted there is a difficulty which—either with this or with a conduit conductor system—at present prevents that economy in working which is essential to any very large reduction of the cost as compared with well-managed horse tramways. We allude to the necessity for the employment of either a very heavy motor or two motors to each car, and to the employment of large generating power where the average motor

power necessary is comparatively small. A motor, or motors, for instance, capable of giving at least 30 h.p. must be fitted to tramcars, which, on an average, do not require more than from 3 h.p. to 6 h.p. This is necessary in order to start these cars or to take them up ordinary gradients. The need for extra powerful motors renders it also necessary to provide a very high maximum generating power as compared with the average power required. This, for instance, is the case at Leeds, and in numerous American towns. On a larger scale it is the same, as, for example, on the City and South London Railway. Here, as we mentioned in our issue of the 12th August, the average power developed by each locomotive requires a current of not more than fifty amperes, although as much as 140 amperes are required for starting the trains. One result of this is that the steam engines which drive generators capable of the maximum load work a large part of all their time upon an uneconomical low load. Another result is the extra cost and weight of the heavy motors or double motors required. In the United States a considerable number of the cars running or being equipped are fitted with two motors, but the greater number are fitted with a single motor and single-reduction gearing with higher-speed motors. The choice between these two systems is perhaps a difficult matter, but although gearing has been made which runs with perfect success with one speed reduction, there is no doubt that so long as the choice is not determined by reference to cost, it is in favour of the two-motor system, and for the reason that it is the more flexible with regard to power available and to power employed. Current may be supplied to both or to only one motor, according to the character of the road, and, as someone has said, when one motor breaks down the other may usually be counted upon to take the car home. To have to carry two motors, however, is to say the least an undesirable thing, especially when carried about by so very jerky a conveyance as the under-carriage of a street car. To overcome the difficulties to which we have referred there still remains the problem of devising a satisfactory means of varying the speed at which an electric tramcar is moved, while the speed of its motor remains constant. In order that it may be practicable to run a tramcar on average roads with a motor of not more than 10 h.p., it should be possible to employ means by which the car could be started at a very low speed, which, after starting, could be changed to the normal speed. At present, for instance, single-reduction gearing is used by means of which, with a motor running at its normal speed, the car is propelled at its normal full speed. The same gear is employed for starting the car from rest, and for this purpose a very heavy current has to be passed through the motor. Attempts have been made to avoid this and its consequences by variable-speed gearing, but none of these have been practicable, or at all events have come into use. Some simple gear for this purpose is certainly necessary, and although we have understood that a practical variable gearing has been devised, we have not yet heard of its adoption.

Steam tramway locomotives have certain advantages in this respect, but the numerous disadvantages have driven it off many of the roads on which it had been placed, and the most economical tramcar haulage still remains but slightly superior to haulage by horses. This part of the question of tramway traction demands attention, and might usefully form a subject for experiment and discussion.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

HOT-STRIP AMMETER.

SIR,—I see from your last number that Messrs. Drake and Gorham have introduced a hot-strip ammeter. Some years ago I made some experiments in this direction, but one of the great difficulties I found was the very sluggish nature of the instrument, which made it impossible to take rapid and varying readings. It would be of interest to know how long it takes for the instrument in question to become steady at the real current, and how long it takes the needle to return to zero. Messrs. Drake and Gorham's instrument would doubtless be very useful in central station work, where a long curve of the approximate current is required, the small variations not being needed.—Yours, etc., E. GEORGE TIDD.

11, Collingham-road, South Kensington, Oct. 6, 1892.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.*

BY PROF. GEORGE FORBES.

LECTURE III.

It is almost impossible for any person at the present moment to give a lecture of any description dealing with electricity without making some allusion to the remarkable lectures that we have heard in the course of last week by Mr. Tesla; and the great bearing which those lectures have upon certain parts of the subject upon which I am lecturing, leads one naturally to say a few words about the remarkable experiments and conclusions that have been before us. I saw in one of the technical journals, this last week, a remark that after the brilliant lecture of Wednesday evening the practical man would ask, "What is this to lead to?" Well, if the man who is in the habit of calling himself the "practical" man were to ask my advice, I should advise him to leave the experiments of Mr. Tesla quite alone. That man is hardly in the position of being able to appreciate, at their right value, the experiments which we saw. I trust that the time is passing by when those who have been in the habit of arrogating to themselve the title of "practical men" will continue to do so. Those men who apply that term to themselves do not realise the self sufficiency which is shown by their assuming such a title. It is the highest praise which can be given to the greatest engineers to say that they are practical men. The man who assumes to himself the title "practical man" is generally the man who can use his hands but cannot use his head—the man who cannot apply theory or interpret a formula—the man who could attend to a well-known type of engine, but who would be incapable of appreciating what an enormous amount has been done in the 10 years that such a thing as a Parsons steam turbine has existed. Our great men do not speak of themselves in this boastful manner as being either practical men or geniuses. Our Watts, our Stephensons, our Rennies, our Bakers, do not boast that they are practical men. They are prepared to become so, but they would not make this boast. The man who largely assumes that title, then, I do not think will be able to appreciate the value of Mr. Tesla's work. But to engineers and natural philosophers it is full

* Cantor Lectures delivered before the Society of Arts.

of importance. Engineers and natural philosophers both look to this work as telling them a deal which has been puzzling them in the past, and as holding out great hopes for the future. There is a great difference between the natural philosopher and the engineer. The natural philosopher claims only to be Nature's pupil. The engineer aims at being her master. In Mr Tesla's experiments the engineer sees great difficulties which have been in his way completely explained and partially removed. He sees what has been troubling him with the use of alternating currents in mains, and how the current was being allowed to leak, and he sees how to remedy that defect. He sees things that have been puzzling him in the action of air condensers, by which the apparent capacity of the condenser is enormously greater than it ought to be if there were not going on that peculiar action of bombardment of the molecules of which Mr. Tesla has spoken so much. The engineer also sees that Mr. Tesla has worked out a system of practical electric lighting producing a most pleasing light—more so than any which we have seen before—and by a means which is almost in a practical shape. The natural philosopher, on the other hand, sees explanations of a vast number of the experiments which have been puzzling him in the past, and sees new developments, new experimental investigations, which will lead to a better knowledge of the ultimate structure of matter. Mr. Tesla triumphs to-day as the natural philosopher. To-morrow he will triumph as the engineer.

The remarks which I have made upon this subject will lead you to see that I place very great importance on what Mr. Tesla has said about the construction of mains. We have long noticed that when an alternate current of high potential and frequency is passing through a wire, there is, in the dark, seen to be a light given off from the wire, especially near a telegraph post on which that wire is supported. This was particularly noticeable in the case of the experiments conducted at Frankfort in this last year, when a large amount of power was transmitted from a distance of 112 miles by a very high tension alternating current. We were at a loss to completely understand what was the action which was going on there and how to overcome it. Mr. Tesla has given us the answer to both; but by going to these very high frequencies and very high voltages he has exaggerated all our difficulties, and thereby been able to see the meaning of them, and to give us the cure for them with the more moderate pressures and frequencies that we use in actual practice. And there is little doubt that he has given us the right explanation of the enormous value of oil as an insulator in all these cases. There cannot be too strongly impressed upon engineers the importance of oil insulation for cables which are carrying high tension alternating currents over long distances. Those sub-station transformers which I was speaking about in my last lecture ought, in the future, to be altogether filled with oil. We had known the value of oil as an insulator before, but we had never realised the enormous importance of it, and now that we do realise the reason why it is so important, it will be very much more largely used.

There are some other mains which I do not speak much about, because they are so generally known. The Siemens concentric mains, of which I have specimens on the table, are extremely valuable for long feeders; but for distributing mains in the town they have the serious disadvantage that a special kind of metal box has to be used to form a junction when taking in the leads into any house that has a light. And the cost of this is so considerable, in order to make the joint perfect, that it seriously interferes with the economy of the mains. But for feeders these concentric mains are admirable. Also the fluid insulators which were introduced by Mr. Brooks—and which will be largely used, I trust, in the immediate future—are extremely valuable for the same purpose for alternating currents.

For the low-tension distributing mains I draw attention once more to the type, of which I have a diagram here (see Fig. 1, Lecture II.), which I feel convinced is the most practical type which can be used for low tension mains. The enormous value of this type of mains lies in this, that we can lay our mains over the whole district which is to be supplied at a very cheap rate at first, when the demand is small, and we are continually able to add to the size of the mains without the slightest difficulty. Then the whole thing is cheap to construct, and the attachments to houses are perfectly independent of the naked cables—the bare wire cables—which we draw through the copper tubes, and which we change for bigger ones when the demand in the district increases.

I come now to the question of power as apart from light, and there are two totally distinct questions in connection with power furnished by electricity, the one referring to the distribution and the other to the transmission of the power, which are often intermingled. The engineer has to consider the two together very often, but they very often are completely separate and have different demands, and may necessitate the employment of different apparatus.

Let me just give an example or two to show how very greatly different is the case under different circumstances.

A great deal has been talked in the last few years about the employment of the Falls of Niagara for supplying power to a distance, it may be. It was originally suggested by Sir William Siemens and Sir William Thomson to carry the power from Niagara into New York, and, later, more practical problems have been presented for carrying that power to Buffalo, a distance of 30 miles, and a manufacturing centre. In either of these cases the great problem is the transmission of the power. To distribute it through the town is not of such enormous importance. The best means which can be devised to carry the power from Niagara to Buffalo, and change it into power there, even though it be in the outskirts of the town, is the solution of a very great problem. But, on the other hand, take the case of a power station situated in London, let us say in Clerkenwell, where there are an enormous number of small factories or small workshops which require power. They have steam engines at the present moment doing a great deal of that work. Those steam engines take up room which is valuable, and they are in the way, and so are the boilers. Again, these small engines are not economical. The consumption of coal is enormous compared with the power given off; and the demand for extra attendants for looking after the boiler and engines is a serious drawback in these small workshops. There could be no place more suitable for putting down a power station than Clerkenwell, but there the demand is totally different to the above case. It is not simply a question of generating power in one station, and then supplying it continuously to the motors in the houses and keeping the motors always going. These motors in the workshops require to be stopped and started at frequent intervals; whereas in the transmission question we do not require to be always stopping the motors. We can be running them steadily all the time. This introduces a very great difficulty, because many motors which are most available to us are incapable of starting freely every few minutes, as when we require to start working a lathe or anything of that sort, and therefore for the distribution of power we must have special kinds of motors which are capable of starting frequently with the utmost ease.

Of course when we are transmitting power to a great distance, it is perfectly obvious that we shall be obliged to use high pressures. If we do not use high pressures we shall be obliged to use large conductors, in order that we should not waste much energy on the road, and consequently, whatever system we are going to use—whether we are using continuous currents or whether we are using alternating currents—we must be dealing with high pressures. Every special case needs to be calculated out on its merits as to the pressure which will be required and the size of the wires which we shall have to use, because we never wish to use a higher pressure than is absolutely necessary. It is always a disadvantage. The difficulties and dangers are always increased when we go to higher pressures. We want to use as low a pressure as is feasible, and will make the thing a commercial success.

As you are all aware, Sir William Thomson, in 1881, laid down a general rule for the economy of conductors. Summarised in the simplest form, it amounts to this, that the interest on the capital invested in copper shall be equal to the cost of the energy which is being wasted in the mains. Some years ago, Prof. Ayrton read a paper before the Institution of Electrical Engineers, in which he considered that Sir William Thomson had made a mistake in

this law, when it was applied to such a case as that of the carrying of power from Niagara to New York; and he argued that this law did not hold. But, as a matter of fact, the whole of the mathematics by which he supported this argument simply resolved themselves into this, that the cost of the energy which you have to take into account is really partially dependent upon the amount of copper that you have put down; that is to say, the farther the distance off from your generating station, the greater is the cost of the copper, and therefore the greater is the cost of the energy; so that, when you go to far distances, you have to allow for a greater cost per horse-power hour than you would have done if you were not going to so great a distance. This is the whole secret of the merits of the case—as I may almost call it—but Prof. Ayrton thought that he had found a flaw in Sir William Thomson's argument.

I pointed this out to a gentleman who gave some lectures on the transmission of power in this hall not long ago, and he slightly misunderstood the explanation which I have just given you, and said that we had to consider as the cost of the energy the cost which that amount of energy would fetch in the market; and that, since the energy was

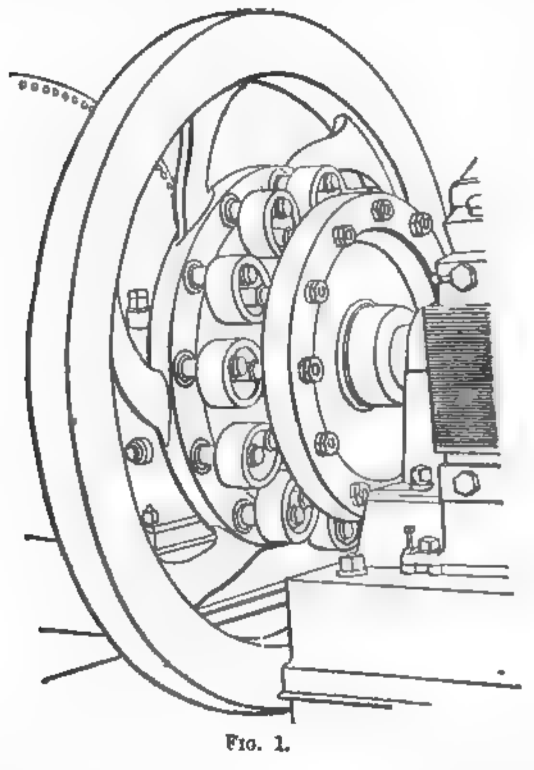


Fig. 1.

more valuable at New York than it was at Niagara, therefore we had to add to the cost of the energy when we were transmitting it to New York. It is not so. It is simply that the cost of the energy is increased by the fact of carrying it to that distance through the copper conductors.

Now, as a matter of fact, in all these cases which come before the engineer of the transmission of power to a distance, the only really satisfactory way of applying the principle of Sir William Thomson's law is to work out the results at several different densities of current; and this involves a very considerable amount of work. You must take approximate figures in the first place, and assume different pressures of the electric current—1,000 volts, 5,000 volts, 10,000 volts, and so on—and work out the cost of sending your power at all these different pressures, and also at different densities of current in your conductor—*i.e.*, with the conductor carrying different strengths of current per square inch of section. This is the only way in which you can really arrive at the greatest economy; and it is very easy in the case of using approximate figures in the first place—you do not waste a great deal of time; it is only when you get nearly to the final result that you need go to at all accurate figures.

Now comes the question: In the transmission of power to great distances, what kind of apparatus are we to use? Are we to use continuous currents? Granted that we are to use high-tension currents, are we to use continuous currents, or are we to use alternating currents? I think that if this question had been asked a couple of years ago, you would have found that nine men out of ten would have answered you that there was nothing open for use except continuous currents. In fact, at the time that the question was in discussion in respect to Niagara, the commissioners who sat and considered the different proposals which had been made, as nearly as possible passed a general resolution for the guidance of the syndicate which had the concession at Niagara, that it was impossible to use alternating currents for the purpose; and yet, within this short space of time, what a transformation has taken place. I suppose that it is more due to the extremely interesting experiments which were carried out at Frankfort during the last year than to anything else, that such a change of opinion has come over the minds of men generally. I suppose that, if the same question were asked again at the present moment, not only would there not be nine persons out of ten who would say that the continuous current was the only one, but I doubt whether there would be more than one out of ten who would say so. I do not in the least wish to undervalue the continuous current and its capabilities of transmitting power at high pressure. I have seen cases where this is being done, and I feel sure that with proper precautions it can be done well. Monsieur Thury, of Geneva, acting for the firm of Cuénod, Sautter, and Co., has erected at Genoa and Geneva, and a number of other places, high-tension continuous-current dynamos. They couple them in series, so as to increase the pressure. The machines are worked up to about 6,000 volts, and they are prepared to go to greater voltages, using 2,000 volts in each machine. The machines are completely insulated from the ground, being put on piers, built up of alternate layers of vulcanised indiarubber and pieces of porcelain. The difficulty which many people thought they saw was the connection with the source of power—the waterwheel or the steam engine—but the firm to which I allude have always used the Raffard couplings, and have been entirely successful with them; and I have no hesitation in saying that it is a very satisfactory arrangement. The Raffard coupling is an extremely simple thing, and of use when we wish to connect two axles together in a line. We place upon each of them a disc, Fig. 1, one of larger diameter than the other. An equal number of pins project through their adjacent faces, near the periphery of each of them; and these two sets of pins, which overhang each other, are connected in pairs by rings of indiarubber, cut off an indiarubber pipe. The result is a flexible coupling, which is extremely valuable mechanically, and which is a perfectly insulated coupling. There is not the slightest difficulty in connecting high-tension machines to engines or turbines with this arrangement, which works perfectly well in practice.

(*To be continued.*)

THE PROBLEMS OF COMMERCIAL ELECTROLYSIS.*

BY J. SWINBURNE, MEMBER.

(*Continued from page 338.*)

Electro-Metallurgy of Copper.

Electrolysis may be employed either in connection with the extraction of the copper from its ores, or in refining copper especially when there is silver alone, or with gold in addition, to be extracted.

In the first case—that of extraction of copper from pyrites—the ore may be converted into matt, and the matt can be cast into anodes, or the ore may be acted on by oxidising solutions produced by electrolysis, or the two processes may be combined.

In the first method the matt is cast into anodes, which are treated in baths of copper sulphate with copper cathodes. The sulphides are attacked, sulphate of copper is formed, sulphur and impurities being left on the anode. The copper is deposited, and iron remains in solution. The chief difficulties in connection with this process are that the anodes are brittle and troublesome, and are often eaten away unevenly, and the solution becomes richer and richer in iron salts. In addition to this, it is stated that the circulation of the iron salts must be avoided, otherwise ferric sulphate will be produced at the anode and reduced at

* Paper read before the Institution of Electrical Engineers.

...tion Name of Promoters.

... Hammersmith Electric ... Power Supply,

... of Works.

...tion.

Oxford Electric Company, Limited.

..., Sheffield Telephone Exchange and Electric Light Company, Limited.

...ot-...ni- The Local Board.

...Sup-...the ...mes. Weybridge Electric Supply Company, Limited.

...ghting ...gh of Corporation.

...Supply ...ough of City of Waterford Electric Supply Company, Limited.

...tion) Electric ...der. The ... of West Corporation.

...Supply Company ...Lighting Order ...of Horsell and ...rish of Chertsey. Woking Electric Supply Company, Limited.

...plications (32 in number) 17 were made by local ... by companies, and one by a firm of electrical ... related to the county of London.

...stance an application was received from the local ...nd another application from a company, for the same ...order was granted to the local authority and the application ...the company was refused.

...llowing statement shows the manner in which the various ...ions have been dealt with:

Title of Order.	How dealt with.
...stwith Electric Lighting ...ler.	Order granted.
...on-under-Lyne (Corporation) Electric Lighting Order.	Do.
...ghton Electric Supply Order.	The promoters failed to produce the consent of the local authority or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the order.
Dublin Electric Lighting Order.	Order granted.
Fareham Electric Lighting Order.	Do.
Govan Electric Lighting Order.	Do.
Halifax (Corporation) Electric Lighting Order.	Do.
Harwich (Corporation) Electric Lighting Order.	Do.
Kilkenny Electric Lighting Order.	Do.
Limerick Electric Lighting Order.	Do.
Liverpool Electric Lighting Order.	Do.
THE COUNTY OF LONDON:	
County of London (North) Electric Lighting Order.	Order granted for: The United Parish of St. James and St. John, Clerkenwell; the parish of St. Luke, Middlesex; the District of the Holborn District Board of Works.
County of London (South) Electric Lighting Order.	Two orders granted: One in respect of the parish of St. George the Martyr, Southwark; the other in respect of the District of the Wandsworth District Board of Works.

... Elec- ...Supply,

...d Kent, 34, S.W.

...and Islington Elec- ...t and Power Supply, ...

the cathode; and this process will go on wasting power over resistance. Some sort of diaphragm is therefore necessary.

It must be pointed out that sulphuric acid can be made from the sulphur dioxide given off in the first roasting of the ores, or from the surplus ferrous sulphate. The ore can be roasted so as to have a good deal of soluble oxide of copper, which can be dissolved in the acid and treated electrically. Merely working with anodes is an incomplete process; it is better to combine it with extraction by lixiviation. The solution, after being in contact with the anode, so as to contain ferric sulphate, is led to the ore. The ferric sulphate is reduced, and the copper and iron are said to be dissolved, and if there is oxide of copper it is taken up by sulphuric acid. This solution is led to the cathodes, where the copper is thrown down, and is then passed to the anodes, where the iron salt is oxidised. The various impurities and the precious metals are left with the sulphur of the anode. The sulphur is burned into sulphur dioxide, which goes to the chamber, and the silver, with the gold, if there is any, is extracted. The sulphate of iron can be burned into sulphur dioxide, and the iron oxide sold as Venetian red. This is, in rough outline, the Marchese process. It may seem strange to those unacquainted with industrial chemistry that if you want to extract copper you should also become involved in making sulphuric acid and red paint; but in chemical works by-products must be utilised, so that often making one thing involves the production of a number of other substances which have at first sight nothing to do with it. Messrs. Siemens and Halske avoid the necessity of making anodes of matt, by employing carbon. The ferrous sulphate is thus oxidised into ferric salt, and this is used to lixiviate the crushed and roasted ore. The solution is then led to the cathodes first to take out the copper, then to the anode to oxidise it, and so on.

In the Hopfner process chloride of copper is used instead of sulphate. The action is stated to be as follows: Cupric chloride is formed at the anodes; this is led to the matt, where it attacks the copper sulphide, forming cuprous chloride and sulphur, and it is also said to dissolve the silver as well as the copper, which, if possible, would be a drawback. I do not know why the chloride should be preferred to the sulphate; and no information is given as to what is done with the sulphur in the ore, and with the excess of ferrous chloride that must be produced.

The Marchese and Siemens and Halske processes are in commercial operation, and the electric extraction of copper is already a growing industry. The E.M.F. necessary for this process is less than a volt; so that, assuming coal to be used as in the estimate at the beginning of this paper, the electrical cost is 14s. 5d. per ton for the extraction of copper. I cannot give the whole cost, as that involves so many considerations. This figure will give copper smelters some idea of the saving of replacing the ordinary refining process by electrolysis.

In dealing with such a valuable substance as copper the time element must not be neglected. The interest on the money locked up in the copper under treatment may be a very serious item. This is an objection of some weight in the case of matt anodes, which take some time to dissolve. The whole of the copper turned out is not obtained from the anodes; but, taken all round, it may not be far wrong to assume that the copper takes about three months to pass through the works where matt anodes are employed. If the output is, say, 1,000 tons a month, the copper represents a capital of some £150,000, and the interest increases the cost of refining some 12s. a ton.

Electrolysis may also be employed for refining crude copper. In this case the process is simplicity itself. The crude copper is made into anodes, and thin plates of fine copper are used as cathodes, the electrolyte being sulphate of copper. Pure copper is deposited on the cathodes, and the impurities and the silver and gold are left in the mud, and the precious metals are extracted in the ordinary way. It is usual to employ cast anodes, and arrange the plates in each vat in parallel, the vats themselves being coupled in series. This arrangement is clumsy, and should be modified. I have had an opportunity of examining the large copper refinery at the Bridgeport Copper Works, and it may be well to describe the arrangement employed there. As the books were examined by Mr. J. H. Hays at the same time, I am also able to give you the actual cost of the process, without having too roseate a hue imparted by an enthusiastic inventor. The refinery is arranged and worked in accordance with the patents of Mr. E. S. Hayden. The departures from ordinary practice are made with the view of reducing the amount of copper under treatment, and of keeping down the cost of labour.

The anodes, instead of being thick cast copper, are sheets of thin rolled metal. The cost of rolling is small, and the plates used can thus be made thin, and dissolved very uniformly. Each vat contains a number of plates arranged vertically and across the vat. At one end a thin plate is supplied as a cathode. The first plate is made the anode, and copper is eaten off one side of each plate, and deposited on the plate next to it. The result is that each vat acts as a number of small vats arranged in series, and requires only two electrical connections. The whole question of large leads and connections is thus solved. There is almost no waste through partly consumed anodes, as the whole plate is eaten away evenly. The process is carried on until the whole of the anodes are eaten, and their place taken by the pure deposited copper. The plates are hosed and removed, and the slime is treated to recover the silver and gold. The product is the highest grade of copper in the market, and fetches £6. 10s. a ton above "tough cake," or £4. 10 above "best selected." Silver and gold are completely separated without loss, and as 35oz. of silver and ½oz. gold per ton are allowed as tare, any copper containing more than that yields £8 per ton in bullion. Argentiferous copper thus yields at least £14. 10s., leaving the gross profit of £12. 10s. at present rates. I have here taken the cost of refining at £2 per ton. The actual cost of refining copper depends on the output of the works and the cost of labour. In Bridgeport it came out just over £2 a ton. With modern dynamos, and reasonably good engines and labour at English prices, the cost would be a good deal less, say, 20s. to 25s. per ton. The use of thin plates as anodes also reduces the capital investment in copper, which, as already pointed out, may be enormous, and thus lessens the margin to be allowed for fixed charges.

The Elmore process is too well known to require a full description. The copper is deposited on a revolving mandrel, and burnished by a travelling agate burnisher. By this means copper tubes of great strength are made, and by cutting the tubes sheets are produced. Narrow strips can also be made, and these can be drawn down into high grade copper wire. A number of thin sheets can be made by depositing several separate coatings one over the other on the mandrel. The sheets separate when the tube is slit lengthways.

Writers of books on political economy are fond of saying that the chaffering of the market makes people manufacture in the cheapest way, and that the cheapest and best goods displace dearer and inferior qualities. They forget the interference of custom, ignorance, and prejudice. If a new process is brought out, it takes ages before it is taken up abroad, and still longer before Englishmen will touch it. Here we have a process of refining copper at a gross cost of £1 or £2 a ton, with a gross profit of £13 or so, and yet copper refiners continue their barbarous methods. The first manufacturers to take up copper refining by electrolysis on really modern principles have a chance of making fortunes before the market is disturbed.

Antimony.

Little has been done in the way of treating antimony ores electrolytically. Dr. W. Borchers proposes to use the solution of sulphide in sodium sulphide as an electrolyte, and to deal with the ores. The specimens of antimony ore that I have examined have been perfect insulators, so that regulus of antimony cannot be used as an anode. There will be an accumulation of sulphur in the bath, and it will probably insulate the anode. It is also difficult to say what material could be employed as anode in such a solution. Carbon would be attacked, and platinum would be too expensive, and other metals would be converted into sulphides. As the reduction of antimony by iron, for example, is comparatively easy, there does not seem to be much opening for the electrolytic treatment in dealing with its ores.

Recovery of Tin from Scrap Tin.

This, of course, can be readily effected by electrolysis. The scrap can be made the anode in an alkaline solution, in which iron is not attacked. Though such a method removes all the tin from the surface, it may leave some alloyed with the iron, as no doubt some tin sinks into the iron during dipping.

Electrolysis has also been employed to assist in cleaning plates before dipping. I do not see how it can be of much service here, however. I have examined one of the processes, and it was said to be working very successfully, but I found the brushes had been accidentally left off the commutator.

Electrical Tanning.

Electrical tanning, though it depends on electrolysis, differs materially from all the processes already described in not depending on the isolation of radicles at the electrodes. Ordinary tanning is a very slow process, because it takes a long time for the tannin to diffuse into leather properly. If this substance is an electrolyte, it has a very complex molecule, and therefore diffuses very slowly. The outside of a thick piece of leather soon becomes tanned, and to some extent protects the rest from the diffusion of more tannin. We may get an idea of what I suggest is the action in electrical tanning by regarding a hide as being made up of cells in groups, with interstices among the groups. If the skin is merely left in tan liquor, it takes months for the liquor to penetrate even into the interstices. It has then to diffuse through the walls of the cells. This is necessarily a very slow process, when it is remembered that the gelatine uses up the tannin as it comes in. Mechanical agitation has been tried, but it does not accelerate the process much. It is probable that agitation helps the liquor into the interstices, but, of course, it cannot help it into the interior of the cells, or, in fact, into those parts of the leather which are accessible by diffusion alone. The agitation can thus only perform the first part of the process—that is, getting the liquor into pores that are open to it.

(*To be continued.*)

ELECTRIC LIGHTING PROVISIONAL ORDERS AND LICENSES.

REPORT BY THE BOARD OF TRADE RESPECTING THE APPLICATION TO AND PROCEEDINGS OF THE BOARD OF TRADE UNDER THE ELECTRIC LIGHTING ACTS DURING THE PAST YEAR.

The following applications for provisional orders have been received by the Board of Trade since the date of the last report:

Title of Order and Description of Area.	Name of Promoters.
Aberystwith Electric Lighting Order. The Municipal Borough of Aberystwith.	Corporation.
Ashton-under-Lyne (Corporation) Electric Lighting Order. The Municipal Borough of Ashton-under-Lyne.	Do.
Brighton Electric Supply Order. A portion of the Municipal Borough of Brighton and the Parish of Preston.	Brighton and Hove Electric Light Company, Limited.
Dublin Electric Lighting Order. The City of Dublin.	Corporation.
Fareham Electric Lighting Order. The District of the Fareham Urban Sanitary Authority.	The Fareham Electric Light Company, Limited.
Govan Electric Lighting Order. The Burgh of Govan.	Commissioners of Police.
Halifax (Corporation) Electric Lighting Order. The County Borough of Halifax.	Corporation.
Harwich (Corporation) Electric Lighting Order. The Borough of Harwich.	Do.
Kilkenny Electric Lighting Order The Municipal Borough of Kilkenny.	Do.
Limerick Electric Lighting Order. The Borough of Limerick.	Do.
Liverpool Electric Lighting Order. A portion of the City of Liverpool.	The Liverpool Electric Supply Company, Limited.
THE COUNTY OF LONDON:	
County of London (North) Electric Lighting Order: The Parish of St. Mary, Islington. The United Parish of St. James and St. John, Clerkenwell. The Parish of St. Luke, Middlesex. The District of the Holborn District Board of Works.	County of London Electric Lighting Company Limited.
County of London (South) Electric Lighting Order: The Parish of Lambeth The Parish of St. George-the-Martyr, Southwark. The District of the Wandsworth District Board of Works.	County of London Electric Lighting Company, Limited.
East London Electric Supply (Hackney) Order. The District of the Hackney District Board of Works.	East London Electric Supply Company, Limited
Hampstead Electric Lighting Order. The Parish of St. John, Hampstead.	The Vestry.
Lambeth Electric Lighting Order. A portion of the Parish of Lambeth.	Ditto.
North London Electric Lighting Order. The District of the Hackney District Board of Works. The Parish of St. Luke, Middlesex. The Parish of Clerkenwell.	Camberwell and Islington Electric Light and Power Supply, Limited
St. Mary, Islington, Electric Supply Order. The Parish of St. Mary, Islington.	Messrs. Sharp and Kent, 34, Victoria-street, S.W.
Shoreditch Electric Lighting Order. The Parish of St. Leonard, Shoreditch.	The Vestry.
South London Electric Lighting Order. The Districts of the St. Olave District Board of Works and the St. Saviour's District Board of Works, and the Parishes of St. George-the-Martyr, Southwark, and St. Mary, Newington.	Camberwell and Islington Electric Light and Power Supply, Limited.
West London Electric Lighting Order. The Parishes of Hammersmith, Fulham, and Battersea, and a portion of the District of the Wandsworth District Board of Works.	Putney and Hammersmith Electric Light and Power Supply, Limited.
Whitechapel District Electric Lighting Order. The District of the Whitechapel District Board of Works.	The Board of Works.
Maidstone Electric Lighting Order. The Borough of Maidstone.	Corporation.
Newbury Electric Lighting Order. The Borough of Newbury.	Do.
Oxford Electric Lighting Order. (Transferring to the Oxford Electric Company, Limited, the rights, powers, and obligations of the Electric Installation and Maintenance Company, Limited, under the Oxford Electric Lighting Order, 1890.)	The Oxford Electric Company, Limited.
Sheffield Electric Lighting Order. The Municipal and County Borough of Sheffield	Sheffield Telephone Exchange and Electric Light Company, Limited.
Sutton (Surrey) Electric Lighting Order. The Urban Sanitary District of Sutton.	The Local Board.
Walton-on-Thames Electric Supply Order. A portion of the Parish of Walton-on-Thames.	Weybridge Electric Supply Company, Limited.
Waterford Electric Lighting Order. The Borough of Waterford.	Corporation.
Waterford Electric Supply Order. The Borough of Waterford.	City of Waterford Electric Supply Company, Limited.
West Ham (Corporation) Electric Lighting Order. The County Borough of West Ham	Corporation.
Woking Electric Supply Company Electric Lighting Order The Parish of Horsell and part of the Parish of Chertsey.	Woking Electric Supply Company, Limited.

Of these applications (32 in number) 17 were made by local authorities, 14 by companies, and one by a firm of electrical engineers; 11 related to the county of London.

In one instance an application was received from the local authority, and another application from a company, for the same area. An order was granted to the local authority and the application of the company was refused.

The following statement shows the manner in which the various applications have been dealt with:

Title of Order.	How dealt with.
Aberystwith Electric Lighting Order.	Order granted.
Ashton-under-Lyne (Corporation) Electric Lighting Order.	Do.
Brighton Electric Supply Order.	The promoters failed to produce the consent of the local authority or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the order.
Dublin Electric Lighting Order.	Order granted.
Fareham Electric Lighting Order.	Do.
Govan Electric Lighting Order.	Do.
Halifax (Corporation) Electric Lighting Order.	Do.
Harwich (Corporation) Electric Lighting Order.	Do.
Kilkenny Electric Lighting Order.	Do.
Limerick Electric Lighting Order.	Do.
Liverpool Electric Lighting Order.	Do.
THE COUNTY OF LONDON:	
County of London (North) Electric Lighting Order.	Order granted for: The United Parish of St. James and St. John, Clerkenwell; the parish of St. Luke, Middlesex; the District of the Holborn District Board of Works.
County of London (South) Electric Lighting Order.	Two orders granted: One in respect of the parish of St. George the Martyr, Southwark; the other in respect of the District of the Wandsworth District Board of Works.

Title of Order	How dealt with
East London Electric Supply (Hackney) Order	The Board of Trade declined to grant the order, as the promoters failed to satisfy them that they were in a position to discharge the duties and obligations that would be imposed upon them by the order, if granted.
Hampstead Electric Lighting Order	Order granted.
Lambeth Electric Lighting Order.	Do.
North London Electric Lighting Order.	The order was granted on the understanding that before the introduction of the confirming Bill the promoters should satisfy the Board of Trade that they were in a position to discharge the duties and obligations that would be imposed upon them. They, however, failed to do so, and the Bill was not introduced.
St. Mary, Islington, Electric Supply Order.	The promoters failed to produce the consent of the local authority or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the order.
Shoreditch Electric Lighting Order	Order granted.
South London Electric Lighting Order	The order was granted on the understanding that before the introduction of the confirming Bill the promoters should satisfy the Board of Trade that they were in a position to discharge the duties and obligations imposed upon them. They, however, failed to do so, and the Bill was not introduced.
West London Electric Lighting Order	The Board of Trade declined to grant the order, as the promoters failed to satisfy them that they were in a position to discharge the duties and obligations that would be imposed upon them by the order, if granted.
Whitechapel District Electric Lighting Order	Order granted.
Maidstone Electric Lighting Order.	Do.
Newbury Electric Lighting Order	Do.
Oxford Electric Lighting Order	Do.
Sheffield Electric Lighting Order	Do.
Sutton (Surrey) Electric Lighting Order	Do.
Walton on Thames Electric Supply Order.	The Board of Trade declined to grant the order, as the promoters failed to satisfy them that they were in a position to discharge the duties and obligations that would be imposed upon them by the order, if granted.
Waterford Electric Lighting Order (Corporation).	Order granted.
Waterford Electric Supply Order (City of Waterford Electric Supply Company, Ltd.	An order was granted to the Corporation and this application was refused.
West Ham (Corporation) Electric Lighting Order	Order granted.
Woking Electric Supply Company Electric Lighting Order.	Ditto.

Bills Nos. 1 to 3 were introduced into the House of Commons on April 11th to confirm the orders relating to Govan, Aberystwith, Ashton-under-Lyne, Halifax, Harwich, Limerick, Maidstone, Kilkenny, Newbury, Sutton (Surrey), West Ham, and Woking (Horsell and Chertsey).

Bills Nos. 4 to 6 were introduced into the House of Lords on May 6 to confirm the orders relating to Dublin, Lambeth, Liverpool, Oxford, Sheffield, Waterford, County of London (a portion of) Southwark, Wandsworth, Hampstead, Lambeth, Shoreditch, and Whitechapel.

Bills Nos. 1 to 3 received Royal Assent on June 20. Bills Nos. 4 to 6 are still before Parliament.

The provisional orders granted by the Board of Trade last session, and referred to in the last report, were all confirmed by Parliament.

Licenses.

The following applications for licenses have been received since the date of the last report, and are at present under consideration.

Name of Company applying and Name of District.

The Ogmore Valley Electric Light and Power Supply Company. (A portion of the district of the Ogmore and Garw Local Board.)

The Shropshire Electric and Power Company, Limited. (A portion of the borough of Shrewsbury.)

The Isle of Wight Electric Lighting Company, Limited. (The Urban Sanitary District of West Cowes.)

Appended is a list of the provisional orders confirmed by Parliament prior to the present session, and of the licenses granted by the Board of Trade since the passing of the Electric Lighting Act, 1882, showing those which have since been revoked or repealed.

HENRY G. CALCRAFT.

Board of Trade, June 23rd, 1892.

(To be continued.)

COMPANIES' MEETINGS.

BRUSH ELECTRICAL ENGINEERING COMPANY

This company was registered in [illegible], 1889, and is a [illegible] works. The authorised capital is £750,000, divided into 150,000 6 per cent. preference shares of £2 each and 150,000 ordinary shares of £3 each. Of the former 75,607 shares, and of the latter 77,978, have been issued and paid up. There is also an issue of £125,000 6 per cent. first mortgage debentures. Dividends paid 1890-91 6 per cent. for the second half of the year. Number of shareholders 1,913. Latest prices: Ordinary, 2¾ 3⅛; preference 2¼.

The third annual general meeting of the Brush Electrical Engineering Company, Limited, was held on Friday, at the Cannon-street Hotel, the Duke of Marlborough presiding.

The **Secretary** (Mr. B. Broadhurst) read the notice convening the meeting; the report and accounts (as given in our last issue) were taken as read.

The **Chairman** said: Gentlemen, I am very pleased to see that there are present here such fair numbers to hear, and not only to read, the statements that will be made by your Board as to the condition of the Company. I think it is a very good thing for a company that the shareholders should take an interest in its meetings, and not, because things are prosperous, leave it entirely to the responsibility of the Board to appear at a general meeting and address only a few members. The last time we met I had only been chairman of this Company a few months, having taken up that post on the resignation of Lord Thurlow, so that this is the first complete year I have had the honour of occupying the chair of this Company; therefore, it devolves upon me to pay somewhat more careful attention to the condition of the Company than, perhaps, one would feel it his bounden duty to do as an ordinary director. Now, gentlemen, in drawing your attention to the leading features of our report and balance-sheet, there are a few remarks which I should like to make to you. In the first place, you will observe that your profit and loss account shows a gross profit of £[illegible]. I will not go into a careful analysis of how these figures are derived, because I should prefer to leave this to my co-director, Mr. Braithwaite, who will give you his view of the incidence of these figures, and how they generally affect the balance-sheet, and to confine myself more to general remarks with regard to these matters. In the first place, remember that the particular feature in the balance-sheet of a company like ours that requires very careful attention is that we are essentially a trading or manufacturing, rather than a commercial company. A commercial company's business settles down into a very steady form. Take the case of a bank; it has always its clients whether trade is good or bad. To a certain extent a railway is the same with its passengers, though they are somewhat more numerous in good times than in bad. That is a commercial company, but this is a manufacturing company, and its business depends on the prosperity of trade and the demand for the particular articles of commerce which we manufacture. That brings me to the remark that the balance-sheet representing the affairs of a trading company requires very careful attention, and I think it should always set forth very clearly the exact condition of affairs with regard to almost every detail. There was a remark made by a shareholder last year with regard to our balance-sheet which I was not prepared to answer exactly at the time, but which has remained in my mind since. It was that there should be some sort of analysis of the statement in the balance-sheet of property, patents, and goodwill. You will observe that the entry in our balance-sheet is £[illegible]. I was asked why that item was not divided, and I confess that at the moment I was not prepared to give an answer. Now, however, I have placed it before the directors, and we have discussed the matter at some considerable length, and the Board has come to the conclusion that in another year we will divide out that item. I cannot congratulate myself in seeing it, so far as the condition of the Company's affairs goes, because I honestly believe that the figures will represent good value. But it divides itself essentially into two values. It would not be right to suppose that that amount represented property merely, and it would be equally wrong to suppose it was all patents and goodwill. But there is this difference in a trading company, that a trading company essentially possesses goodwill, which is a legitimate and tangible asset. At the same time it is an asset which is contingent—that is to say, it is contingent on your existing as a company, and continuing in a good condition of trade. Supposing trade fell off in the silk industry of Coventry, for instance, there would

be no goodwill, the trade having gone, and therefore, in the case of this Company, it is wise to attempt to discriminate between these items of property, patents, and goodwill. Patents, of course, are to a large extent difficult to value, and therefore I do not see that we can discriminate entirely between the value of patents and goodwill; but in the next balance-sheet, the Board having consented to adopt this course, I hope to see a division of these items. Whatever may be the condition of many industries in this country—and some, I fear, have languished a good deal, trade not having been as prosperous in many directions as we might have hoped—I think that real and steady progress is being made in the electrical industry. No doubt, to a certain extent, the industry is on its trial. If there were one or two electrical financial disasters connected with these large central station undertakings, I think it would create great nervousness; but, on the other hand, I see no necessity to have any such fear. As far as I myself am concerned with this large industry in the City, it affords to me complete satisfaction, and I see no prospect of any disaster or any difficulty occurring. Therefore, seeing that the electrical industry is on an absolutely sound commercial basis, you, as a trading company, I think, have very good prospects before you. The result of this year's trading has been that you are the possessors of a certain abnormal profit this year—a profit which does not come absolutely into this year and cannot be expected every year; that is to say, a large sum has been received on account of the City contract, and Mr. Braithwaite will explain to you how we have dealt with the matter. We have taken that profit and divided it in a certain way which I think is quite legitimate; we have only placed that portion to the dividend fund which would legitimately represent the working profits of the year. Another portion of that profit has been used for writing off certain losses, and Mr. Braithwaite will explain how those losses have arisen, and the reason the Directors have used this money for the purpose of writing them off. Then, another portion of the money has been set to a reserve fund, which appears in your balance-sheet as a contingent reserve. Therefore, taking the general condition of the balance-sheet as it stands, I think it compares very favourably with last year's balance-sheet, and from many points of view is much stronger. On the other hand, I am bound to point out that we cannot always expect to be in the same position unless the trade progresses. There are many competitors in this field, and, there is no question about it, we cannot monopolise all the orders, and, in fact, we are obliged, in order to be in a prosperous condition, to have a very large turnover in the course of the year, so as to be able to present you with what I call a favourable balance-sheet. All these things must be remembered, and it depends very much on the exertions of your officers and your Board to keep us in the van of this industry. I may say I recognise that a great deal of work is thrown upon the officials of the Company in this respect, and in viewing the course of the work during the year, I observe a large amount of labour has been bestowed by them in trying to popularise the Brush industry with town councils and local authorities likely to go in for this work, and I hope that some of this popularising work will be able to be done by members of the Board. In fact, the Directors of this Company must look upon themselves to a large extent as principals in a business rather than sleeping partners, whose function is merely to audit accounts. It is a business which must be pushed, and, under these circumstances, I think you have a good investment for your money and a good prospect before you in this industry. I will not go very critically into the balance-sheet, as I have asked Mr. Braithwaite to address you on that subject, beyond saying a few words on a certain point. The policy of the Company is to concentrate all its works at Loughborough. The Falcon Works, which we acquired in the amalgamation brought about in 1889, are being added to, and we hope in the course of the year to abandon the works in Belvedere-road completely, and carry everything down to Loughborough. Your Board have visited Loughborough on several occasions this year. I was only able myself to visit it once, the other day; but I can speak most favourably of the manufactory you possess down there. The engines and dynamos which are being made for the City of London are of a most approved character, and seem to promise to turn out everything that could be desired. The winding shop, which is at present in London, will be transferred to Loughborough, and some small delay in the execution of orders will, no doubt, take place owing to that transference; but I trust, nothing to seriously impede the capacity of your Company for carrying out the contracts which it has in hand. The prospect with regard to orders is good; several orders of importance are at present in hand, and the prospect of the coming in of further orders, as I say, seems to be favourable. You will observe that your debenture issue has been completed in the course of the year, and that you are practically borrowing now a larger sum of money for the same amount of interest. I observe, also, in this balance-sheet a thing I am bound to call your attention to, and that is that amounts have from time to time been added to the property, patents, and goodwill account. Now, that is another reason for pointing out the advisability of dividing these items. The balance-sheet occasionally becomes a mere statement of account, all of which hangs upon this item, and unless that is capable of complete analysis it is very difficult to arrive at the position of affairs. Such an item is used, in fact, as a sort of waste-paper basket, into which everything is put. The profit on the debenture stock has been added to the property, patents, and goodwill, and, no doubt, it is legitimately goodwill; but, at the same time, it is well that shareholders should understand how that is arrived at, and I think I am bound to point it out. With regard to the work done for the City of London Electric Lighting Company, it, I believe, has met with the approval of that company in every respect, and I anticipate that we shall have no difficulty in carrying out the contract we have there, and I hope there will be no loss of any sort. You will understand that in this industry one of the great difficulties is not to make a loss on a contract, because we are often obliged to undertake work in which there was no previous experience, and in which we have to compete with other firms ready to go in for the same thing, and we sometimes are bound to have losses where we are obliged to go outside our ordinary experience. I am glad to say, however, that that is not of frequent occurrence; but Mr. Braithwaite will explain one instance in which we have met with this difficulty, and have written off the loss. We exhibited, as you will see in the report, at the recent Crystal Palace Electrical Exhibition, and that exhibit attracted very considerable attention from the public, and has done, I believe, considerable good in bringing the position of the Company into public notice. I would like to add a few words with regard to the question of our foreign business. The Australasian business promises, I believe, to give us a profit on our future orders—a tangible profit—and I think that business may progress. There is no doubt that our colonies ought to be good customers of this Company. Whether they will be so I, personally, have not sufficient knowledge to be able to form an opinion, nor have I any knowledge of Australasian matters. With regard to our Vienna business, I think I may say that the business at Temesvar has been acquired by the town for a fixed sum. I believe that negotiation is practically concluded, and that we may look upon that as an asset which has been turned into money. Mr. Garcke, your former managing director, and whom, I am glad to think, we still have with us as a director, has taken a great deal of trouble in the matter, and we owe him a very great debt of gratitude, because I do not think that anything could really represent a fair recompense to him for the enormous amount of trouble taken by him in connection with your Austrian business. He has been instrumental in concluding the matter, and I think you owe him a great debt of gratitude for undertaking it. With regard to the rest of the Vienna industry, we hope that the day will come when we shall be able to hand over that business to what I would call a native organisation, and that we shall be able to retain a solid interest in the same. There are so many difficulties and anxieties in carrying on an industry of that sort in a foreign country, and we should like to see our work, if possible, all concentrated at home. I do not think I need keep you any longer, for I think I have told you fully the position in which we stand. We have every reason to be satisfied with the year's working. The balance-sheet speaks for itself, and with regard to the item of valuation of the properties and the goodwill of the Company, that is an item which, although it has descended to us from the amalgamation, I think thoroughly represents the tangible assets of the Company. I have, therefore, every confidence in saying that I believe you may be fully satisfied with the last year's working, and that the dividend which you are now to receive is one which has been honestly and fairly earned. It is now my duty to move the adoption of the report, and Mr. Braithwaite will second the motion.

Mr. J. B. Braithwaite seconded the motion, and entered in detail on the chief items in the accounts. To pay 6 per cent. on the ordinary shares required £7,000, and, bearing that sum in mind in relation to the amounts that had been written off out of profits, they would see the amount of prudence the Directors had exercised. The gross profit of £55,757 had only been arrived at after making ample provision for anything that seemed at all likely to turn out unsatisfactorily in future years. They had received this year the initial payment for the large contract they had in connection with the City of London lighting, and it therefore seemed prudent to clear away anything in their accounts which was in the slightest degree unsound. They had written off £1,636 as provision against losses on some contracts carried out in foreign countries, and had also written off the entire cost of the compound winding action, viz., £2,861, made a provision of £4,000 for any possible further bad debts, although at present none were in sight, and written £1,000 off the provisional order account and another £1,000 in connection with the opening of their new show rooms in Regent-street. It would thus be seen that had the Directors been so disposed they could have paid a higher dividend. They were determined, however, not to increase the dividend from 6 per cent. until they saw they could retain it at the increased figure, and he thought the shareholders would agree with the Board's policy in thus placing the Company on a thoroughly sound basis. There was a large increase in the item "staff bonus", but the shareholders had already sanctioned the Board's proceedings in that respect. The business was conducted on the system commonly called profit-sharing. At the present moment 64 of their officers and employés were on the bonus staff, comprising all those who had been with them two years and were paid a monthly salary. It was intended to extend the system to those who were paid weekly wages. He thought the system they had adopted would identify the interests of the men with those of their employers, and was the best way of meeting the labour question. With regard to the contract for the lighting of the City, work to the amount of £50,000 had already been executed, so that they had £240,000 in that contract with which to begin the new year. There was no reason to doubt that the present year would yield a bigger profit than the last. In conclusion, he congratulated the shareholders on having at last entered on a career of commercial prosperity, which so many of them had looked forward to through some years of difficulty and cloud.

Mr. C. R. Fry raised the question of the issue of shares which had taken place during the year, and complained of their not having been offered to the shareholders.

Mr Braithwaite said the shares had previously been offered to the shareholders, and declined by them and the Board, in disposing of a small block to make up an even number, accepted an offer by certain gentlemen on the Stock Exchange, paying only a commission of 1s a share to those who took the risk of taking shares which were not quoted in the official list.

The motion was adopted, and a resolution confirming the interim dividend of 6 per cent on the preference and ordinary shares for the half year ended December 31, 1891, and declaring dividends at the same rate on both shares for the half year ended June 30, was also agreed to.

The retiring Directors and auditors were re-elected, and the proceedings then closed with a vote of thanks to the Chairman and Directors.

COMPANIES' REPORTS.

PRETORIA LIGHTING COMPANY, LIMITED.

Directors' report to the shareholders of the Pretoria Lighting Company, Limited.

Your Directors have much pleasure in submitting for your approval this their third report on the affairs of the Company together with the balance-sheet and profit and loss statement made up to the 30th June last and the auditors' report on same.

Buildings and Machinery Contracts.—The contract for the station buildings was placed in the hands of Messrs. Murdoch and Haldane, who have executed their work in a most creditable manner and to the entire satisfaction of the Board. Messrs. Crompton and Co., Limited, handed over the electrical machinery and plant on the 1st June last. Your Directors called in Mr. J. Hubert Davies, the well-known electrical engineer of Johannesberg, to inspect the whole of the works. Mr. Davies has sent in a preliminary report, and will send in a final one after the 1st September, when the three months trial of the machinery by the contractors is concluded. You will remember that Messrs. Crompton and Co., Limited, bound themselves under a penalty clause to complete their works by the 31st March last. As this was not carried out, this matter was also referred to Mr. J. H. Davies, who advised your Board that good and valid reasons had been advanced by Messrs. Crompton and Co., Limited, for the non-fulfilment of their undertaking.

Extension System.—On the arrival here of Mr. J. Cushny (Messrs. Crompton and Co.'s representative) it was discovered that the original system of distributing the mains was unsatisfactory and unworkable. A new plan had to be devised (involving an additional expenditure of something under £3,000), which your Board sanctioned, and which is now nearly completed, whereby the distribution of electrical current is made available to every house within the boundaries of the city.

Electrical Machinery.—The plant consists of five sets of boilers, engines, and dynamos, together with 102 lamps for street lighting, with all poles, insulators, etc.; about 35 tons of copper conductors, distributed on the underground and overhead systems, and with all necessary instruments required for a central station. Your Directors think that the Company can congratulate themselves on possessing one of the most thoroughly equipped and efficient stations in existence at the present time. It can be mentioned that the plant is capable of supplying current to about 6,000 lamps of 8 c.p. capacity, in addition to the energy required by the Government for the public lighting contract.

Supply of Current.—The Company commenced, on the 10th June last, the supply of light to 48 of the public lamps, the Staats-drukkerij (State printing office), and to a few private consumers. The whole of the public service could not be started simultaneously, as a certain number of the lamps are on the extension system which will not be finished until the 1st September. Up to date 72 private installations have been or are being connected to the Company's mains. A full statement of all installations with revenue accruing from same, made up to the date of the general meeting, will be laid before you for inspection.

Engineer.—Your Directors have secured the services of Mr. John Carmy as resident engineer, the appointment to date from September 1st next.

Management.—Your Directors have also appointed Mr. Hirschel Cohen to the dual position of manager and secretary.

Retiring Directors.—Messrs. C. Hanau and J. B. Taylor retire in order of rotation, but are eligible and offer themselves for re-election.

Auditors.—You will be asked to appoint a new auditor or auditors in the place of Messrs. Cowen and Wilkinson, who have left the State, and to confirm the appointment of Mr. A. Scott Rankin, who was chosen by your Board to conduct the audit of the accounts now before you, and to fix the remuneration for same.

Balance-sheet.—The statements as laid before you need hardly any comment. From the profit and loss account you will see the revenue and expenditure from electrical supply for the 20 days' work during the month of June and one or two special services, but as few private installations had then been effected, and as the Government was only charged half of the contract price, the details are no guide to the proportion of revenue to expenditure. You will also notice that the amount of £3,346 7s has been carried to preliminary expenses account.

Preliminary Expenses.—Your Directors have decided that the amount of £4,543 5s 8d expended during the past three years (including an amount of £1,741 0s 2d taken over from the old Z.A.E.M.) on the various items affecting the formation of the Company, and other amounts not directly chargeable to the construction account shall be written off over a course of seven years, and the amount that will consequently be charged annually to profit and loss account will be £649 0s 10d.

Prospects of the Company.—Your Board are happy to be able to state that the prospects of the Company are favourable in the extreme. The popularity of the new light is evidenced by the daily applications for current from the public, and your Board will make every endeavour to maintain that popularity by meeting the consumers in every possible way, feeling that the interests of the shareholders and the public are inseparable, and are even now considering a scheme whereby the advantages of the electric light will be brought home more clearly to every householder. It must be stated that the operations of the Company have been inaugurated in a most auspicious manner. It is almost without record in the electrical world that an installation of the magnitude possessed by this Company should have started and worked so smoothly, successfully, and without a single hitch, as has been done in these works since the 10th of June last.

NEW COMPANIES REGISTERED.

New Electro Metallurgical Syndicate, Limited.—Registered by H. C. Bull, 29, St. George's-road, N.W., with a capital of £10,000 in £1 shares. Object: to acquire certain patents relating to the production of metals by electrolysis, and the recovery and purification of the by-products arising therefrom and apparatus therefor. Registered without special articles of association.

BUSINESS NOTES.

Burnley.—The Burnley tenders must be sent in by the 19th inst.

Windsor.—The tenders for public lighting at Windsor must be sent in by to-morrow (Saturday).

Dundee.—The Dundee Gas Commission require a travelling crane for the electric light station.

Great Northern Telegraph Company.—The receipts for the month of September were £24,000.

Ardrossan.—The contract for lighting the harbour was carried out by Messrs. Mavor and Coulson.

Bolton Tramways.—The Bolton Corporation are prepared to receive tenders for the lease of their tramways.

Telegraph Poles.—The Controller of Stores at the General Post Office requires tenders for telegraph poles by the 21st inst.

Toronto.—The electric lighting contract at Toronto expires next year, and new tenders will be invited to be sent in this month.

West India and Panama Telegraph Company.—The receipts for the half-month ended September 30 were £2,470, against £1,602.

Wimborne.—Tenders are required for lighting the public streets of Wimborne for three years, to be sent to Mr. Dibben, clerk, by 10th inst.

Eastern Telegraph Company.—The receipts for the month of September were £55,710, as against £50,789 for the corresponding period.

Grafton Galleries.—Messrs. Pyke and Harris have secured the contract for the whole of the wiring and fittings for the above galleries, in which there are 230 lights.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent payable to the London Platino-Brazilian Company, were £3,613.

Dublin.—The Dublin Corporation are expecting to make a very large revenue from their electric light station. The large business places and hotels are beginning to take it extensively.

Austrian Telephones.—The Telephone Company of Austria has declared the usual half-yearly dividend to the 30th ult. on the preference shares at the rate of 6 per cent. per annum.

Reuters.—The Directors of this Company have declared an interim dividend at the rate of 5 per cent. per annum, tax free, for the half-year ended June 30, payable on the 12th inst.

Telephone Company of Austria.—This Company has declared the usual half-yearly dividend to the 30th ult. on the preference shares at the rate of 6 per cent. per annum, payable (less income tax) forthwith.

Dolgelly.—The details of the lighting of this town show a very favourable aspect. Some 70 or 80 lamps, it will be erected at a cost less than that charged by the gas company for the same number of lights.

Belfast.—Correspondents in the Belfast papers are pressing for the introduction of the electric light in that town, and the suggestion is made that the example of St. Pancras should be taken as a model for imitation.

Middlesbrough.—At a meeting of the Electric Lighting Committee of the Middlesbrough Council on Tuesday, the sub-committee's recommendation that the Council apply for a provisional order next year was agreed to.

Chatham and Rochester.—An order for the supply of alternate-current generating plant and transformers for this station has been placed with the Brush Electrical Engineering Company.

Victoria Embankment.—Although the electric light will eventually be installed on the embankment for the County Council some time must elapse before this can be done and as additional light is required another gas lamp has been added.

Fire Alarms.—The Glasgow Police Commissioners have invited tenders for renewing and maintaining the street fire alarms and telegraph lines. Particulars of Mr. W. Paterson, chief officer of Fire Brigade, Central Fire Station, Glasgow.

Change of Partnership.—Messrs. Swinburne and Co. inform us that Lord Russell has ceased to be connected with them and that Mr. Bertram R. Beale has joined the firm, which will continue to carry on the business under the same name.

Norwich.—The Norwich Electricity Company is busily employed in putting up the buildings for the central station, and in laying the mains through the streets. Every care seems to be taken in carrying out the work, which should therefore result in complete success.

City and South London Railway Company.—The receipts for the week ending October 2 were £786, against £748 for the same period last year, or an increase of £38. The total receipts for 1892 show an increase of £883 over those for the corresponding period of 1891.

Claybury.—At the County Council meeting on Tuesday, the Asylums Committee reported that they had accepted the tender of Messrs. Latimer Clark, Muirhead, and Co. for the electric lighting of Claybury Asylum, for £15,130. The list of tenders was given on July 29.

Woolwich.—The Highways Committee of the London County Council report that the application for extension of time (six months) for a provisional order at Woolwich has been granted by the Board of Trade, and that the time for making the deposit has been extended to 5th February, 1893.

Artificial Indiarubber.—A fortune awaits the man who can make artificial indiarubber out of turpentine. *Industries* thinks the subject "well worthy of the devotion of long labour." The electrical trade certainly would be pleased, and it would not be less important to the engineering trade.

Brazilian Submarine Telegraph.—The Directors recommend a further dividend of 3s. per share, making 6 per cent. for the year ended June 30th, together with a bonus of 1s. per share. The reserve fund has been increased by £40,000, and £3,073 carried forward to the credit of the current year.

St. Pancras.—The contract for the supply of Brockie-Pell lamps for the extension of public lighting in the St. Pancras district has been placed with Messrs. Johnson and Phillips. The district to be lighted includes the Hampstead road, High street, Camden Town, and other principal streets in the neighbourhood.

Glasgow.—The Electric Lighting Committee of the Corporation of Glasgow expect to be in a position to begin supplying the new light to private consumers not later than December 1. It is further expected that the illumination of the principal streets in the central district of the city will be accomplished before the close of this year.

Birkdale (Lancs.).—At the meeting of the Birkdale Local Board, complaints having been made against the quality of the gas supplied to the district by the Southport Corporation, it was stated that a report would be submitted to the next meeting of the Board relative to the contemplated scheme of supplying the electric light.

Admiralty Boats.—We are advised by Messrs. Woodhouse and Rawson United, Limited, that they have received official notice from the Lords Commissioners of the Admiralty to the effect that their name has been placed on the Admiralty list of firms who may be called upon to tender for the construction of unarmed wood built boats and the supply of engines for the same.

Accrington.—The Accrington Town Council on Monday sanctioned a scheme for purchasing land for and erecting, at a cost of under £10,000, an electric lighting station to supply the town with electric light. The land to be secured includes the Higham Public Baths, which will be taken over by the Corporation. The Accrington Corporation have also under consideration the purchase of the gas and water works for £700,000.

Canterbury.—It is seldom that business premises get favoured like the telephone company at Canterbury, of which it was said at the last meeting of the Board of Guardians that the company had not yet been assessed. However, representatives of the four unions in the district had met and recommended that a valuer be appointed to value the company's property in the four unions, so that we expect the assessment will not now be long delayed.

Glasgow Engines.—Messrs. Lindsay, Burnet and Co., engineers, Govan, have completed the delivery and erection of the steam generating plant for the electric lighting of Glasgow. It comprises five large boilers of the marine multitubular type, built under the survey of the Board of Trade for a working pressure of 160lb. per square inch. These have all been successfully placed in the space provided for them in the basement of the new buildings erected in Waterloo street.

Wandsworth.—The committee of the London County Council reported on 5th July last, that the undertakers under the Wandsworth District and Camberwell Electric Lighting Orders, 1891, had failed to satisfy the Board of Trade of their ability to discharge their duties and obligations, and that the Board proposed to revoke the orders. Notices have since been received from the Board of Trade that the orders have been revoked as from the 25th of July and the 26th of August last respectively.

Change of Address.—Messrs. J. Sunderland and Co. have removed their works from Raven street, Halifax, to more suitable premises situated at 183, Gibbet street, and hope to have the whole of their machinery in thorough working order within the next few days. Having increased their plant they are now able to undertake any description of high-class instrument work, in addition to the ordinary patterns of telegraphic, telephonic and general signalling appliances hitherto manufactured by them.

Florence.—The new national library which is being built to contain upwards of 4,000 volumes, 380,000 pamphlets, 17,000 manuscript volumes, 950 parchments, and 190,000 autograph letters and documents in the present collection and to provide for future extension, is to be lighted throughout by electricity and will employ telephonic apparatus and, in fact, all modern aids to assist in the quick communication and delivery of works required. The ultimate capacity is for upwards of 2,000,000 volumes.

Coventry.—At the Coventry Town Council meeting last week, the Electric Light Committee reported that schemes and estimates for a central electric light station from six firms had been submitted and considered. They were from the following: Brush Electrical Engineering Company, Limited, Messrs. S. Z. de Ferranti, Limited, Messrs. Hammond and Co., Electric Power Storage Company, Limited, Electrical Construction Corporation, Limited, for Verity and Co., Messrs. J. H. Holmes and Co.

Communication with Lightships.—The statement that the Royal Commissioners to enquire into the feasibility of connecting lightships with the shore had advised that the East Goodwin lightship should be connected by telegraph wire with Dover is premature. The Commission holds its next meetings on the 18th, 19, and 20th of next month, when the report of the recent visit paid to the different lightships will be considered, and evidence will be taken from coastguard officers and masters of lightships.

Private Laboratory.—The address of Mr. Desmond FitzGerald is now 94, Loughborough-road, Brixton, and his laboratory is at 75, Akerman road, near by. The laboratory is devoted to experimental work in connection with secondary batteries, electrolytic bleaching and alkali production, as well as standard cells. Mr. FitzGerald has done much most valuable work in fields of electrical research, of which the lithanode cells are one of the most recent successes. It is to be expected that we shall hear of many other equally important advances as the result of his private laboratory.

Southampton.—The Special and General Works Committee reported the receipt of a number of tenders for the fitting of the electric light at the Corporation water works at Otterbourne, the protecting tender of Mr. Aldridge, electric engineer, being £318, 16s. 3d. Mr. Bone, in proposing the adoption of the report, stated they had received no less than 25 tenders, ranging from £398 to £227 10s., the lowest. He had had an interview with Mr. Aldridge, who recommended the acceptance of the tender of Messrs. Statter and Co., who had the contract for the electric work at the quay, for £245, and he proposed that tender be accepted, and it was accepted.

Hastings and St. Leonards.—The municipal authorities of Hastings and St. Leonards have just decided to illuminate the whole of the front line of this fashionable watering place with the electric light. At present gas and electricity are both employed to light the principal portion of the Parade, the other parts of the town being lighted only with gas. The Corporation, however, have now determined to do away with the gas altogether, and to use the electric light as the sole illuminant for the Parade, from the fish market to the end of the West Marina—a distance of three miles. This will place Hastings and St. Leonards in the enviable position of possessing what will probably be the most brilliantly-lighted sea front in the kingdom.

Whitehaven.—A correspondent to the *Whitehaven News* is in a tearing rage over the adoption of the electric light scheme. He makes several misstatements. The scheme he says, "is supported not on reason and statistics, but on hope and expectation." What is the report of their consulting engineer? The price of electricity at Newcastle, he says, "where coal is 6s. a ton, is 6d. a unit." Should it not be 4½d.? He thinks a meeting of ratepayers should be called before going on with "this gigantic scheme," which he is afraid will lead to ruin. Why does not the good man read the report of the Government enquiry, when his doubts would be set at rest? No one expects every person in Whitehaven to take the light at once. But that there is room for it is abundantly shown.

Eastbourne.—At the Eastbourne Town Council meeting on Monday, the following report from the Lighting Committee was presented: "'At a meeting, on the 20th September, a letter was read from the Assistant Secretary (Railway Department), Board of Trade, enclosing copy of correspondence which has passed between the Board and the Eastbourne Electric Light Company, Limited, with reference to the provisions of section 7 of the Eastbourne Electric Lighting Order, 1890, and enquiring if the Corporation have any observations to offer with regard to the ability of the company to perform the duties imposed upon it by the order. A statement of the company's accounts was also submitted. Resolved, 'That so far as this committee is concerned the company has performed its duties satisfactorily, and they see no reason why they should not continue to do so in the future.'"

Dundee.—The Dundee Gas Commission have issued rules regulating the applications for a supply of electric light, of which an installation is at present being introduced into the city. Along with them the charges are intimated as follows: Electric energy up to 20 Board of Trade units, 8s. 4d. per quarter; each unit above 20, 5d.; meter registering one unit per hour, 4s. per quarter, increasing gradually to 12s. 6d. per quarter for meters registering 15 units per hour. A letter has been received from the Board of Trade, in which it is stated that recent experience has shown that in the case of a system of laying mains such as that approved of for Dundee under the order for the feeder mains, in which the conductors consist of bare copper strips supported on insulators in conduits, serious damage and even danger may result from allowing any accidental contact with earth to remain in the system.

Maidstone.—The Electric Lighting Committee of the Maidstone Local Board recently met for the further consideration of the report which they presented to the Board on the 17th August, and, after discussion, adopted substantially the same recommendations as were originally made. These were as follows: "That Mr. W. C. Hawtayne be engaged to prepare the necessary plans, estimates, and specifications, and carry out the entire scheme; that Mr. Hawtayne be required to reside in Maidstone during his engagement; that he be permanently engaged to manage and start the lighting, and required to act as resident engineer in charge of the works for a period of at least 12 months after their completion; that during his engagement Mr. Hawtayne be paid a salary of £200 per annum." The cost of supplying electric light of the same illuminating power as a given gas light will, it is calculated, be about three times as much as the cost of the gas.

Pretoria.—Elsewhere we give the directors' report to the shareholders of the Pretoria Lighting Company, which seems very satisfactory. It will be within the recollection of our readers that this installation was carried out by Messrs. Crompton and Co., but it is due to that firm to state that the original system of distributing was not from their designs, but from the design of the original engineer of the company, who, we believe, has since ceased to act for the company. The contractors—and we think justly—claim great credit in that, considering the great distance of Pretoria from England, and the fact that all the machinery had to be transported by means of bullock waggons over a distance of some 170 miles up country. As will be seen from the report, the whole of the machinery has worked satisfactorily from the commencement; indeed, the directors and their engineer (Mr. Cushney) are to be congratulated upon the success of their work.

Birmingham.—The proposal is being raised to convert the Birmingham Central tramways from steam to cable roads by means of several subsidiary companies. The capital would be reduced. Mr. Ebbsmith says, with reference to the electric trams: "So far as regards the Bristol road electric line I advocate a policy of careful observation and economy, a rigid supervision of the leakages which appear at present to be inseparable from the use of secondary generators, and if possible an adjustment of salaries so that a payment by results may give every incentive to the staff employed. I should certainly deprecate any alteration or conversion until our observations have been far more lengthened, or until we are satisfied that science cannot remove the present obstacles to success." Generally, he thinks, the steam engine will have to give place to the steel rope, and that great care should be exercised in selecting the first routes. A detailed scheme is to be drawn up.

Siemens Bros. and Co.—The following interesting note appears in the report of the Building Act Committee of the County Council last week: "That the application of Messrs. Siemens Bros. and Co., Limited, for approval of plans for the construction of an iron enclosure to a proposed electromotive workshop at their premises, Bowater road, abutting upon Harrington road, be granted, upon condition that the whole of the work be executed to the satisfaction of the district surveyor, and that if the plans or application be hereafter found to be inaccurate in any particular, the approval of the Council shall be null and void. That the application of Messrs. Siemens Bros. and Co., Limited, for the consent of the Council to the erection of an electric locomotive workshop at their works, Bowater road, abutting upon Harrington road, such workshop to contain more than 216,000 but not to exceed 450,000 cubic, as shown on the plans accompanying the application, be granted, and that the solicitor do prepare the license of the Council."

Kimberley.—The *British and South African Export Journal* says of the work of Messrs. Mather and Platt at this exhibition: "This eminent firm of the Salford Iron Works, Manchester, are so well known in connection with the supply of electric lighting plant in the principal towns and mines of South Africa, that it is only natural to find them undertaking the electrical installation at the Kimberley Exhibition. The machinery employed will consist of three arc light machines of the firm's popular Manchester type. Each of these will have a capacity of 800 volts 10 amperes, and will be arranged to work 18 lamps in series. The incandescent lamps will be supplied by three dynamos, each for 100 volts 130 amperes. For the interior illumination of the building 700 16-c.p. incandescent lamps will be used. These will be provided with suspension fittings and ornamental coloured glass shades, so that the effect should be very pleasing. In the grounds there are to be 36 arc lamps of the Brockie-Pell type. These will each be of 2,000 nominal candle-power, and they will be supported upon lofty standards made by the Sectional Standards Company, Limited. A special feature of the electric lighting arrangements of the exhibition will be a powerful search light, which has been specially lent to Messrs. Mather and Platt by Messrs. R. E. Crompton and Co. It is of the Admiralty type, with a 24in. lens, and will be worked by a current of 100 amperes.

City and West-end.—Among the many contracts recently obtained by Messrs. Drake and Gorham may be mentioned the Bank of British North America, Clement's-lane; the Bank of Egypt, Old Broad-street; the London Assurance Corporation, Royal Exchange; the London residences of Lord Knutsford, 75, Eaton-square; the Hon. George Eden, 51, Cadogan-place; and Mr. J. W. Lowther, M.P., 16, Wilton-crescent. They have also obtained the contract for the wiring of the Alliance Assurance Company's offices, 1, St. James's-street, in addition to the chambers above. Several country houses are being rapidly fitted up, including Foxbury, Chislehurst, for Mr. H. H. Tiarks, where the plant will consist of two 4 h.p. nominal Otto gas engines, each driving a five unit dynamo, and there are two complete sets of cells, the whole being interchangeable. The same firm are also fitting up an installation for Mr. Swinfen Eady, Oatlands Lodge, Weybridge, where the plant will consist of a 3 h.p. nominal Otto gas engine, a three unit dynamo, and a battery of 53 accumulators. A large amount of work is also being carried out in the neighbourhood of Manchester, both plant and wiring.

London County Council.—The Highways Committee of the London County Council report that they have considered a notice dated August 8, 1892, from the London Electric Supply Corporation of intention to lay distributing mains, consisting of concentric lead-covered cables drawn into iron pipes, in Savile-row, Old Burlington-street, Cork-street, Clifford-street, and Boyle-street. They see no objection to what is proposed, and, therefore recommend that the sanction of the Council be given to the works referred to upon condition that the company give two days' notice to the Council's chief engineer before commencing the works, in the carrying out of which only one side of any thoroughfare shall be obstructed at one time; that the mains be laid under the footways, and be kept 9in. below the under side of the paving wherever it is found practicable to do so; that where the mains cross the carriageways they be kept at the same depth below the concrete or the road material as the case may be; that no street boxes shall be constructed until the positions for, and the mode of construction of, them shall have been submitted to and approved by the Council's chief engineer; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk of injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casting; and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps, in addition to any other covering. The committee have also received notice from the House-to-House Company of intention to lay mains in Penywern-road, Cranley and Drayton gardens. The mains referred to will be laid in 3in. iron pipes, and the proposed works appear to be unobjectionable. They recommend that the sanction of the Council be given to the works referred to upon condition that the company give two days' notice to the Council's chief engineer before commencing the works in any of the streets referred to in the notices; that no pipes of a larger diameter than 6in. shall be used; that the street boxes shall be of the pattern approved by the Council; and that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover shall be efficiently connected to earth. The committee further recommend the approval of notices to lay mains by the St. Pancras Vestry in cast-iron pipes, of the St. James's and Pall Mall Company, of the Metropolitan Company, of the Kensington and Knightsbridge Company, all of which are sanctioned subject to approval of the chief engineer.

Taunton.—Some fierce controversy is still going on in the *Somerset Express* over the purchase of the electric light station. Alderman Standfast has written, on his side, asking "what became of the £12,000?" and Mr. Massingham has replied, explaining. The *Express* adds a note, saying: "If Mr. Massingham will allow his brother directors to make public the figures we have asked for—i.e., the actual cost incurred in producing the electricity sold in Taunton during the last year and the actual amount paid for same—he might add the *Express* on the side of the purchasers. Until that is done we shall continue to oppose the blind purchase of what may turn out to be a bad bargain." The following information is also given in another issue of that paper: "As might have been expected, the Taunton Gas Company, as a body of ratepayers, has memorialised the Board of Trade asking that the license for electric lighting applied for by the Town Council be not granted. The memorial is signed by the chairman, vice-chairman, and secretary of the company, and the objection proceeds on the ground that the Council intend to purchase the electric works, and that said works have hitherto been carried on at a loss and would, if transferred to the ratepayers, entail a heavy burden on the town. The memorialists ask, in conclusion, that if a license be granted, that a clause should be inserted therein making it obligatory on the Town Council to charge for electric light supplied to private consumers a sum that would, at least, cover the cost of the production and the interest and other necessary expenses. A copy of the memorial has been sent to the town clerk. The electric lighting company had intended to have supplied the electricity by meter, on and after 29th September instant, but finding some difficulty in doing so they have instead revised their tariff, and will,

after the date mentioned charge a higher rate, by 2s. 9d. per annum, for every 16-c.p. light. The average price charged for 16-c.p. incandescent lights was 16s. per annum; the new price will now be 18s. 9d., or an advance of about 16 per cent. This brings the price up to about 8d. per unit, and is in accordance with the recommendation of Mr. Kapp. It was, however, in the private arc lighting that Mr. Kapp found that the principal loss was incurred, 41 private arc lamps being supplied for £410, or about £10 per lamp per annum. The charge, he contended, ought to be £22. 10s. If that advance were submitted to, it would mean something like £450 more money every year from those who use the electric light in these arc lamps. Until that price is insisted on the tradesmen who are using these lamps at the old prices are not paying cost price for their light. As regards the public lamps these pay £22. 10s., and are no loss to the company. Not only so, but there has recently been an increase made or sanctioned in the area lighted by electricity to the extent of seven lamps. For these the charge will be £157. 10s., the charge for gas lamps over the same area having been between £30 and £40. The ratepayers are thus paying some £115 per annum more for an improved street light in North Town and some other parts of the borough. This is in addition to the three or four hundred extra already paid for North-street, High-street, Fore-street, and East-street, so that the ratepayers are paying about £500 a year extra for the electric light. It is the users of these 41 private arc lamps who have been supplied under cost price at the cost of the shareholders—a loss which they are trying to shift on to the ratepayers. To this objection has been made from three distinct quarters, and the action of the Board of Trade is awaited by applicants and objectors. It is pointed out that the cost of incandescent lamps brings the price up to 6d., not 8d. per unit. Further, that though the Town Council at one time sanctioned erection of seven additional lamps, only five have been erected, and the order as to the other two has been indefinitely postponed."

Scarborough.—At a special meeting of the Scarborough Town Council, Mr. E. H. Gawne proposed the adoption of the minutes of the Sanitary and Lighting Committee, which contained a report of the Electric Lighting Sub-Committee, the principal clauses in which were that Mr. A. A. Campbell Swinton form a company to take over the powers granted to the Scarborough Corporation by their Electric Lighting Order, 1891, together with all the duties and liabilities of the Corporation under that order, such company to be formed within a period of eight weeks from October 1. The Corporation also to have the option of acquiring the undertaking at the end of 21 years upon paying for the undertaking as a going concern including the valuation of the goodwill (but without any allowance for compulsory purchase), such valuation to be made on the basis that the powers of the company would cease and determine at the end of the said thirty-second year, and upon the further basis that the dividend paid by the Company shall be taken not to have exceeded a cumulative dividend of 10 per cent.; the amount of valuation in case of dispute to be settled by arbitration. The maximum price of current to private consumers to be 7d. per Board of Trade unit. The maximum price of current to the Corporation for public lamps is to be 6d per Board of Trade unit, such price to be reduced at the rate of one farthing per unit for each £1 per cent. per annum on the cumulative dividend declared above 8 per cent per annum, after making allowance for depreciation and reserve fund, the amount to be placed to the credit of such depreciation and reserve fund respectively in any one year to be approved by the Board of Trade and not to exceed 6 per cent. on the capital for the time being expended by the company on the undertaking in the case of the depreciation fund, and 2 per cent. in the case of the reserve fund, and the total amount of such depreciation fund never to exceed so much per cent. on such capital as the electrical engineer of the Corporation shall fix, and the total amount of such reserve fund never to exceed 25 per cent. on such capital. Such depreciation fund to be used only for repairs or renewals, and in case of the undertaking being taken over by the Corporation the depreciation fund to pass and become the property of the Corporation without payment or consideration whatsoever. Councillor John Hall seconded, and went into detail on the subject of the electric lighting of the town. It would not be wise, he thought, for the Corporation to do the work themselves, but they could give it over to some company, to be hereafter formed, under the powers contained in the provisional orders that the Corporation possessed. It would be necessary if the Corporation undertook the work to secure a loan of £25,000 to £30,000 to produce the electric light. It therefore seemed to the committee that it was the wisest course to adopt to hand over the work to a company. The company would safeguard itself and would not spend more money than was absolutely necessary in laying down plant and carrying out the scheme. The Council were further safeguarded by the terms of the agreement. In addition, they would be able to take over the lighting if so desired by the arbitrator of the Local Government Board. Everything, therefore, seemed in favour of the Corporation. Councillor Edmon thought it would be better for the Corporation to undertake the work themselves. Councillor Whittaker said the company would not have a monopoly of the lighting of the borough; they would be in keen competition with the gas company. They need not, therefore, fear paying an exorbitant rate, beyond a fair percentage on the capital invested. After further discussion, during which Mr. G. T. Eaman entered a lengthened protest, the minutes were carried with but that gentleman's dissent.

Croydon.—A meeting of the Croydon County Council was held last week, when the Council decided to adopt the committee's suggestion, and retain the provisional order themselves. The General Purposes Committee's report was as follows:

When, in obedience to the desire of the Council, the sub-committee proceeded to consider the offer to take over the powers contained in the Corporation Electric Lighting Order as referred to in paragraph 4 of the last report of the committee, it appeared to the sub-committee desirable that the Council should, when particulars of this offer were presented, also know what other offers, if any, could be obtained. The sub-committee therefore caused advertisements to be issued inviting tenders. As the result of these advertisements five proposals have been received, of which the particulars will be found below in sub-paragraphs *b*, *c*, *d*, *e*, and *f*. Sub paragraph *a* contains the particulars of the offer mentioned in paragraph 4 of the last report and above referred to.

Offer A.—(*a*) It is proposed to form a local company to take a transfer of the provisional order, and carry out and establish a central station, it being stipulated that within seven days of the Council agreeing to transfer the provisional order, the erection of a central station should be proceeded with. If it should become desirable later on to erect other stations in other parts of the borough, the company would, it is stated, be ready to meet all requirements. The Corporation to have the option, after seven years and within 15 years from 1890, to purchase the undertaking at a price equivalent to the capital expenditure properly incurred with an addition of 33 per cent. thereto.

Offer B.—(*b*) To take a transfer of the provisional order, and to construct an electric lighting station on the high-tension alternating system. The Corporation to provide at a nominal rent a site for the erection of a station. The contractors to pay to the Corporation the costs of obtaining the provisional order, and to give an option to the Corporation to purchase the undertaking at the end of 21 years, or any succeeding five years upon the same terms as are provided by the Electric Lighting Act for the purchase of an undertaking at the end of 42 years.

Offer C.—(*c*) To form a local company to take a transfer of the provisional order, and to carry out electric lighting thereunder upon such system as may be determined. The Corporation to enter into a contract with the company for the electric lighting of the main thoroughfares upon terms to be agreed. The Corporation to undertake not to consent to to another provisional order or license during the continuance of the agreement. The price of electricity to be reduced one farthing per Board of Trade unit for each 1 per cent. made beyond a cumulative profit of 10 per cent. after allowing for depreciation and for a reserve fund. The Corporation to have the option at the end of 21 years, and each subsequent 10 years, of paying therefor as a going concern, including valuation of the goodwill.

Offer D.—(*d*) A local company to take a transfer of the provisional order, and to carry the same out upon the moderate high-tension system, combined with the most recent improvement of low-tension distribution from sub-stations. The maximum price of electricity to be 8d. per unit. The Corporation to have the option, upon six months' notice, to purchase the undertaking upon the following conditions: I. Up to 1902 by issuing to the company such an amount of Corporation stock as will produce an annuity of 4½ per cent. per annum upon the capital expended upon the works, and also upon payment to the company of such sum as will, together with the dividends paid, amount to 5 per cent. per annum upon the paid up capital to the date of completion of the purchase. II. Between 1902 and 1912 by issuing to the company such an amount of Corporation stock as will produce an annuity of 4½ per cent. per annum upon the capital expended on account of the undertaking. III. Between 1912 and 1922, either upon the terms of II. or upon payment of the then value of the undertaking according to section II. of the Electric Lighting Act of 1888, together with the value of the goodwill to be settled by arbitration. IV. On December 31, 1922, or at expiration of any seven years thereafter, either upon the terms of II. or upon payment of the then value of the undertaking in accordance with section II. of the Electric Lighting Act, 1888.

Offer E.—(*e*) To form a local company to take a transfer of the provisional order, and establish a central station at an estimated cost of £20 000. To raise a capital of £25,000, and to pay the Corporation a bonus of 5 per cent. thereon—viz., £1,250. The balance of the £25,000 would, it is expected, be absorbed by the expense of forming the company and issuing the capital. The Corporation to have the option to purchase the undertaking on payment of £25,000 for the first installation, as well as all moneys actually expended upon subsequent installation, and in addition five years' purchase of the average annual next profits during the three years previous to the exercise of the option. Such average net profits to be ascertained by taking the dividends actually paid, and any reserve, depreciation, or sinking funds to remain the property of the company.

Offer F.—(*f*) To take a transfer of the provisional order, and to give the Corporation the option of purchasing the undertaking at any time during the continuance of the order at a price consisting of the capital expended on the undertaking, and a sum equal with dividends earned to 7½ per cent. per annum upon the investment from the commencement of the order, the contractors undertaking to supply electric current for the public street lamps at cost price.

Copies of the several offers referred to may be seen at the town clerk's office. The Council will observe that under either of the above-quoted offers, if the Corporation should desire to repurchase the undertaking, they will have to pay a substantial profit upon the sum actually expended by the contractors, and they may find themselves in the position of having to take over a considerable amount of plant which at the time of purchase may be out of date and of little value, but which the Corporation will have to acquire, not at its then value, but at a considerable premium on its original

cost. In the event, too, of the Corporation desiring to purchase the undertaking, questions will certainly arise as to what should be deemed to have been a proper expenditure of capital, and disputes may ensue, the settlement of which will involve considerable expense. The transfer of the powers of the Corporation will involve the interference, by a company, with many roads and footpaths in the borough, the entire control over which it would be far better should remain in the hands of the Council. It will be observed that four of the offers made involve the formation of local companies, and it is probably contemplated by those from whom the offers proceed that some portion of the capital will be locally subscribed. As to this there may be some difficulty, and, although in case of offer "A" a guarantee is given that the erection of a central station would be immediately proceeded with, yet any failure to obtain local capital would probably lead to considerable disappointment, and possibly result in some delay in completing the installation. The Corporation, it is certain, will be large consumers of electricity for the new municipal buildings and library, and eventually consumers on a very large scale for street lighting. Many of the corporations which have obtained electric lighting powers within the last two or three years have now determined to keep those powers in their own hands. The following figures show the result, to a recent date, of the introduction of electricity into Bradford, where the Corporation have undertaken the electric lighting of the town:

		No. of lamps fixed.	Total receipts	Total expenses.
1890.	June 30	4,000	£858	£898
,,	Dec. 31	6,880	1,552	1,174
1891.	June 30	8,500	2,093	1,261
,,	Dec. 31	13,436	3,592	1,591

Taking all these circumstances into consideration, the committee recommend that the Council should determine to carry out the powers of the provisional order itself, either now or at a future date, the committee being authorised to ascertain and report what additional expenditure would be involved by the installation and plant for lighting the new Town Hall and library, being of sufficient capacity also to supply consumers within the compulsory area, and being designed with a view to future extensions. This information will enable the Council to determine whether it would be wise to carry out the powers of the provisional order at once, or for the present to confine the operations to the new buildings.

PROVISIONAL PATENTS, 1892.

SEPTEMBER 26.

17151. **Improved "wall," "table," or floor connection for portable electric lamps.** Andreas Peter Lundberg, 18, Regina-road, Tollington-park, London.

17160. **Improvements in telephone switchboard apparatus.** John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

17169. **Improvements in or relating to the electrolytical decomposition of metallic salts and in apparatus therefor.** Charles Kellner, 46, Lincoln's-inn-fields, London.

SEPTEMBER 27.

17206. **Continuous electric current machines and motors.** William Aldred, 5, Brightside-bank, Brightside, Sheffield.

17207. **An improved ear piece for telephones.** Thomas Johnstone, 27, Kirkgate, Bradford.

17209. **Improvements in the slides of electric sliding pendants.** Robert Hall Best, Cambray Works, Handsworth, Birmingham.

17222. **Improvements in or relating to electric metal working or welding.** William Philips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

17223. **Improvements in or relating to welding or working metals electrically.** William Philips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

17224. **Improvements in apparatus for electrically heating and working metal.** William Philips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

17225. **Improvements in the method of and apparatus for electrically welding metals.** William Philips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

17226. **Improvements in the method of and apparatus for welding or heating metals electrically.** William Philips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

17227. **Improvements in or relating to electrically welding or heating metals.** William Philips Thompson, 6, Lord-street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

17242. **Improvements in electro-medical appliances.** Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (Sophia Hetherington, Arrataers, New South Wales.) (Complete specification.)

17244. **Improvements in or relating to the supply of electricity to electrically propelled and controlled aerial machines.** Charles Camlonga, 46, Lincoln's-inn-fields, London.

17246. **Improvements in or connected with electric primary batteries.** Thomas Joseph Davies Rawlins, 1, Quality-court, Chancery-lane, London.

SEPTEMBER 28.

17287. **A new or improved shield or cover for electric gas lighting purposes.** Joseph Hamer, Commercial-street, Halifax.

17299. **Apparatus for the inhalation of metals or minerals vapourised by means of electricity for medical, antiseptic, or other purposes.** Edmund Savary d'Odiardi and Eva Savary d'Odiardi, 55, Cornwall-gardens, London.

17320. **Improvements in electric heaters.** Thomas Ahearn, P.O. Box 1,071, Ottawa, Canada. (Complete specification.)

17321. **Improvements in electric water heaters.** Thomas Ahearn, P.O. Box 1,071, Ottawa, Canada. (Complete specification.)

SEPTEMBER 29.

17381. **Improvements in and relating to telephonic instruments.** James Muirhead, 96, Buchanan-street, Glasgow.

17423. **Improvements in apparatus for supplying electricity to electrically-propelled vehicles.** Emile Chabeault, 46, Lincoln's-inn-fields, London.

SEPTEMBER 30.

17462. **Improvements in and apparatus for moulding earthenware electric switches, ceiling roses, bell pushes, and the like, and forming screw threads thereon.** Joseph Mier, 55, Market-street, Manchester. (Complete specification.)

17466. **An improved electro metallurgical process.** Henry Clay Bull and Gustavus Baron de Overbeck, 15, Water-street, Liverpool.

17467. **Improvements in driving sewing machines by electricity.** Henry Lee, 7, Staple inn, London.

17471. **Improvements in electrical motor and fan combined for filtering and fumigating the air.** Samuel Coxeter and Henry Nehmer, 4, Grafton-street, Gower-street, London.

OCTOBER 1.

17491. **Improvements in the application of electricity to the human body.** John Stevenson, Norwood Lodge, Middlesbrough.

17494. **Electric indicator and apparatus for cooling any part of machinery which may become heated by friction.** Hugh W. Horne, 5, Causeway side, Edinburgh.

17504. **Improved operating electric switch.** David Loch, 55, Calvert road, East Greenwich, London.

17509. **Improvements in the construction of field magnets of dynamo-electric generators.** Thomas Reginald Andrew and Thomas Preece, 20, Charles-street, Bradford.

SPECIFICATIONS PUBLISHED.

1891.

15414. **Electric lamps.** Kelway.

17192. **Electric distribution.** Wright.

18595. **Electric motors.** Harrison and Budd.

19196. **Electric lamps.** New.

19450. **Electric apparatus.** Marsh and others.

19852. **Magnetic separators.** Hoffman.

22025. **Electric light fittings.** Smallwood.

1892.

1436. **Dynamo-electric, etc., machinery.** Johnson. (De Bovet.)

13562. **Electrical accumulators.** Young. (Colgate.)

14189. **Distributing electric currents.** Lake. (Stanley and another.)

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3
— Pref.	—	[illegible]
City of London	—	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
House-to-House	5	[illegible]
Metropolitan Electric Supply	—	[illegible]
London Electric Supply	5	[illegible]
Swan United	[illegible]	3¾
St. James	—	[illegible]
National Telephone	5	4¾
Electric Construction	10	[illegible]
Westminster Electric	—	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	3½

NOTES.

Wolverhampton.—A site has been selected for the central station in Wolverhampton.

Paris.—Baron de Pfeffel succeeds M. Victor Popp as managing director of the Paris Compressed Air Company.

Death of Tennyson.—Lord Kelvin was one of the band of eminent pall-bearers at the funeral of Tennyson, at Westminster Abbey, on Wednesday.

Antwerp Exhibition.—The Superior Industrial Council at a meeting in Brussels on Wednesday decided that an international exhibition should be held at Antwerp next year.

Search Lights. — A 50,000-c.p. search-light is to be placed on the statue of Liberty in New York. It is to be similar to that at Mount Washington, and will be visible 100 miles.

Cheap Electric Motor. — The *Scientific American* describes in a recent number a new simple but efficient motor, placed on the market at the ridiculously low sum of four shillings.

Technical Schools.—A technical school is to be erected at Bridgend, Glamorganshire. The Radcliffe Technical Instruction Committee intend to erect a school at a cost of £3,000.

Lamp Rate.—It is stated that an influential section of Bradford inhabitants, afraid of the advances of electricity, are proposing a small "lamp rate" to meet any loss on the gas, instead of raising the price.

Colonial Telegraphs.—A circular is being sent to all the chambers of commerce with reference to a proposed new cable between Canada and Australia. The Associated Chamber is expecting to take up the question shortly.

Aluminium.—The soldering of aluminium, which has long been a difficult problem, has been recently solved. By sprinkling the surface to be soldered with chloride of silver, and melting down, the soldering is effected simply and satisfactorily.

Cheltenham.—Mr. Norman, in proposing the adoption of the minutes of the Cheltenham Electric Lighting Committee, said an arrangement had been made with Prof. Ayrton to confer with him and inspect the St. Pancras and other lighting systems.

Sweden.—It is pleasant to see that Niagara, Rheinfelden, and the Tivoli falls are not to have an exclusive utilisation of large water powers. In Sweden, for instance, the great Trollhatta waterfall, near Gothenburg, is to be utilised to the amount of 6,000 h.p.

Nottingham Goose Fair.—A noticeable feature of the great goose fair at Nottingham last week, says a correspondent, was the fine effect of the combined electric and gas lights on the central area, which bathed the concourse in silvern and golden hues.

Tudor Accumulators. — The Société Anonyme Franco Belge, which manufactures Tudor accumulators, has opened a laboratory and office for dealing with installations using accumulators, at 19, Rue de Rocroy, Paris. M. Priaux is their engineer.

Birmingham.—A site containing 2,846 square yards of land has been selected in Commercial road, Birmingham, for the central electric station, the cost being £1,900. The Finance Committee are to be authorised to raise Corporation stock to erect the plant.

Domestic Electric Lighting.—Messrs. H. Alabaster, Gatehouse, and Co. have now in the press, shortly to be issued, a new work, entitled "Domestic Electric Lighting, Treated from the Consumer's Standpoint." The author is Mr. Ed. C. de Segundo, A.M.Inst.C.E.

Paris.—In Paris, out of 85,000 houses, there are only 20,000 lighted with gas, whereas 175,000 electric lamps are in use. At present the plant at the municipal central station can keep 96,000 lamps constantly lighted, and the generating power will soon be doubled.

Middlesbrough.—The chairman of the Middlesbrough Electric Lighting Committee thinks it would be the height of folly to introduce the electric light at the expense of the ratepayers. An order is to be obtained to enable the Council to hold their ground for a year or two.

Calorimeter.—A delicate calorimeter was recently described by Messrs. J. A. Harker and P. J. Hartog at Edinburgh. This is essentially a Bunsen ice calorimeter, with solid acetic acid instead of ice, so being much more delicate, and capable of being used at ordinary temperatures.

Macclesfield.—The first introduction of electric light into Macclesfield has been carried out by Mr. W. R. Brown. The dynamo is driven by a 5-h.p. Tangye gas engine, a 3,500-watt Elwell-Parker dynamo being used. The shop is lighted by 32-c.p. lamps, and the windows have 200-c.p. lamps.

Albert Palace.—Mr. John Burns has announced that an anonymous donor has promised £10,000 for the proposed Albert Polytechnic for South London if the Vestry and the Charity Commissioners make up a similar sum. The Vestry are to hold a special meeting to consider this munificent offer.

Bradford.—The Markets and Fairs Committee recommended to the Council the acceptance of the tender of Messrs. Andrews and Preece for supplying and fixing the necessary fittings for lighting Kirkgate Market by electricity. The amount of the tender is £1,440. The recommendation was adopted.

Electricity in Harvest.—The Rev. G. B. Stone, preaching at St. Thomas's, Garstang, at the harvest festival, gave credit to the steamboats, telegraphs, and telephones for their share in the success of the cereal supplies of England, and hinted at still greater developments of the use of electricity in harvesting.

Accumulator Traction.—MM. Huber and Magée have recently developed a system of electric traction, entitled an improved method of electric locomotion by direct intermittent feeding by secondary batteries. The method is stated to be eminently practical, and further details are obtainable of M. Barrault, 58, Chaussée D'Antin, Paris.

Telephone from Liverpool to Llanwddyn.—A committee of the Llangollen District Board has been appointed to superintend the laying down of 24 telephone poles along the roads in the townships of Lledron and Lloran Isa in connection with the project of the Liverpool Corporation to establish a communication between that city and the Vyrnwy Water Works.

Plymouth.—The gas company at Plymouth seem to have been making great improvements in the public lighting recently by the introduction of new burners. Mr. Bazley, speaking at a ratepayers' meeting, said it was hoped that the gas company had at length realised the fact that the only way to stave off the electric light was to see that the gas supplied was of the best quality.

Kingswood.—Attending the Kingswood Local Board last week, Mr. Parfitt, representing the electric light company, explained that the limited light which had been complained of was due to the lamps. The company intended to put new lamps at once, which would remedy

this. The cause of the lights going out one night was due to lightning puncturing their insulation in several places.

Provincial People's Palaces.—A handsome and spacious building has been opened at Glusburn, Crosshills, Craven, near Keighley, being the gift of Mr. J. C. Horsfall, C.C., to be used as a "people's palace" and technical institute. Mr. Horsfall has simultaneously closed The Red Lion Inn, of which he was owner, to induce the younger generation to spend their time more advantageously than at the public-house.

Dividends.—The *Gas World* points out that the high dividends of the private companies, like the Brush, may be ascribed to the fact that trade is bad—not because it is good. For the municipality can take advantage of a dull period to borrow money cheaply and embark in electric lighting. It adds, the Brush Company having already shared profits with those receiving monthly salaries, now intends to bring in the wage-earners also.

Endowment of Research.—Sir James Crichton-Browne, treasurer of the Royal Institution of Great Britain, has received from Mr. Thomas Hodgkins, of Setanket, Long Island, New York, a donation of £20,000 to the funds of the institution, to be applied in promotion of scientific research. Mr. Hodgkins recently presented £40,000 to the Smithtonian Institution at Washington. The idea is spreading in some quarters that the giver really meant to endow the Royal Society.

Manchester Association of Engineers.—A paper with an interesting title is to be read before the Manchester Association of Engineers on November 12, by Mr. B. H. Thwaite, of Liverpool. It is on "Economic Possibilities of the Generation of E.M.F. in the Coalfields and Its Application to Industrial Centres." Before the same association on March 11 next year, Mr. C. R. Iorns is down for a paper "On the Relations between Employers and Workmen in Engineering Works."

Electric Traction Finance.—Sir J. Whittaker Ellis is understood to be visiting America with the express object of inspecting the various systems of electric street railways in the States, with the intention of giving attention to the financing of important schemes in this country. Mr. Steinway, the eminent pianoforte maker, of New York, is in London, it is stated, with the same laudable desire to give Britain the advantage of financial support to the long-tarrying schemes for rapid electric locomotion.

Feed-Water.—Researches made by Prof. Lewis, of the Royal Naval College, more particularly as to marine boilers, on the burning of boilers, demonstrated that collapse is often due to the presence of oil or grease in the feed-water. Mr. J. B. Edmiston, of Liverpool, has devised a filter of flannel and wire cloth to cleanse the feed-water previous to injection, and an inspection of one of these filters after use shows their usefulness in stopping impurities. The feed-water filter has already been applied to many boilers.

Electric Fishing.—Experiments have recently been made in the Toulon Roads for illuminating the bottom of the sea with electric lamps. The whole apparatus, weighing 132lb., was sunk in six fathoms, and illuminated the bottom to a radius of nearly 100ft. An immense quantity of fish were attracted—so much so that the idea was expressed that it would contribute to the wholesale destruction of fish resorts on the coast. The lamp is thought likely to afford the greatest service for surveying wrecks or reconnoitring for submarine mines.

American Roads.—The wretched condition of the roads in most towns in America is one of the first observations of the traveller. If we have much to learn from their great progress in electric traction, they have more to learn in the construction of ordinary roads. Indeed, the well-known disinclination of Americans to walk and the progress of mechanical means of traction is probably largely due to their bad roadways. It is interesting to learn that an attempt is being made to have a comprehensive exhibit of roads and roadmaking at the Chicago Exhibition.

Popular Electricity in France.—The spread of interest in electricity has led to the establishment in all countries of a number of new electrical papers, amongst which, in France, we notice one under the expressive title *Electricité pour Tous* (Electricity for All), issued at the modest price of 15c., or 1½d. It is an eight-page fortnightly, containing articles on batteries and so forth, and current notes, not too highly scientific, of electrical progress, with cuttings on general electrical items. It may be made into a bright and popular technical paper.

Mining in Malay.—The first ordinary meeting of the second session of the Institution of Mining and Metallurgy, London, will be held on the evening of Wednesday, 19th inst., in the lecture theatre of the Geological Museum, Jermyn street, S.W. (the use of which has been kindly granted by the Lords of the Committee of Council on Education), at 8 o'clock. After an address by the president a discussion will be held on the paper on "Mining in the Malay Peninsula: a Field for Mechanical Appliances, Hydraulic and Electrical Transmission and Power," read by H. M. Becher, Esq. (member), on June 15.

Odylic Force.—We have often to call attention to absurd statements in the newspapers on electrical matters. The provincial papers are the worst offenders, though the London papers are not immaculate. Not enough is the puffing of electropathic boots or whatnot, but we must actually have electric control of the weather. According to a note that has been going the rounds, a Mr. John Collinson, "of London," claims the gift of being able to control the elements by "odylic force," discovered 20 years ago—a crystal "acting as a magnet on a sensitive" is to still winds and waves. The most extraordinary part is that he can get responsible editors to suggest in good faith that the Agricultural Department, Lloyd's, and others, might do well to appoint a committee of 12 to investigate these ridiculous pretensions.

Accumulators.—Captain Khotinsky, writing in our namesake in America, points to a condition to which attention has been called before, but which should be consistently kept under notice. He says: "In experimenting with one cell filled with well-mixed 10 per cent. solution of acid, after a few successive charges and discharges, I found that the specific gravity of the acid in a charged cell changed so that in the upper part 2½ per cent. and at the bottom 30 per cent. of acid was found in solution. From this confirmed fact it follows that the lower part of a plate must be sooner destroyed by extra work imposed on it by the stronger acid and by the same agency in the lower part. The internal resistance is reduced, while in the upper part of the plate, by reason of the lighter acid, the opposite occurs, and the internal resistance is therefore increased."

Electro-Metallurgy.—Those who were fortunate enough to attend Mr. J. Wilson Swan's lecture on "Electro-Metallurgy" at the Royal Institution, or to inspect the apparatus afterwards shown privately in his laboratory at Bromley, will have at once recognised the great practical importance that will be likely to accrue from the adoption of the methods of quick copper deposition there explained and demonstrated. We are pleased to notice that these experiments have attracted attention in the great centre of metallurgy—Birmingham—and in the forthcoming Midland

Institute lectures, for which many of the most eminent men of the time are engaged in their special subjects in science or literature, Mr. Swan's name is down for a lecture on "Electro-Metallurgy." The occasion will be of great interest to the manufacturers and scientific men of that city, and we notice that Messrs. Elkington, the well-known electroplaters, who were first in the field to utilise Faraday's discoveries, will have their interesting collection of apparatus on view at this lecture.

Electric Fireworks.—The electric light is becoming an acknowledged accessory of fireworks on the occasion of fêtes. For instance, the good ship "Ravenswood," which is wont to ply for excursions up the Bristol Channel, took her farewell trip for the season last week along the Somerset coast to Clevedon. As it was known that fireworks and other special attractions were to be provided on board, there was a very large number of passengers, and the quay wall at Bristol was lined with people who had come down to see the vessel start. After passing the Suspension Bridge coloured lights were burnt from the stern of the boat, and directly afterwards a searchlight which had been fitted up astern was turned on. The search light, which had been supplied by Messrs. King, Mendham, and Co., and was of the type used in the Royal Navy, was fitted with an arc lamp of about 5,000 c.p., with reflector and glass lens in front of the lamp. The current was supplied by the dynamo that provides the electric light to the ship. The light was worked by Mr. A Rouch, superintendent electrician to the firm above mentioned, and caused great amusement when suddenly flashed on various objects during the journey down the river.

St. Pancras. At the meeting of the St. Pancras Vestry on Wednesday, Mr. A. Sweet, chairman of the Electricity Committee, stated that no rate whatever would be required to be levied in respect of electric lighting purposes. It was further stated that High-street, Camden Town, would be illuminated with arc lamps on high iron columns, in a similar way to Euston road and Tottenham Court road. The committee, having inspected the arc lamps of various makers, and considered their respective merits, were of opinion that the arc lamp (the Brockie Pell), now in use in the parish was, at this period, the best lamp that could be adopted for street lighting. Applications for the electric current had been received from residents on the west side of Gordon square, and it was decided to lay a main for the purpose of supplying the desired current. Mr. N. Robinson, one of the members of the London County Council, asked Mr. Sweet whether the electric system adopted in the parish was a financial success and likely to pay its way. Mr. Sweet replied that so far from the electric system having proved a failure financially, he was surprised that so large an undertaking should have been carried out without the necessity of any rate whatever. Already they had more orders for the electric current than they could supply with their existing station. There was not the least doubt that the present installation would pay. Answering Dr. Bell, Mr. Sweet said, "Of course the Vestry were supplying electricity at a profit."

Hull Tramways.—Some little time ago it was announced that the Hull tramways were to be leased to a London syndicate, who would institute electric tramcars. We communicated with the authorities, and were given to understand there was no truth in the statement, but it seems there must have been, for the Works Committee at their last meeting submitted a scheme for the purchase of the tramway systems in Hull, construction of the same with double lines, and the leasing of them to a London syndicate, to be run by electricity. There were several objections to the details of the scheme, and after a long discussion, a motion for the adjournment of the debate until after the November elections was lost, and a resolution come to to discuss the objections. The period of the lease, 30 years, was objected to by Alderman Leak, who thought that the Corporation should have the option of taking over the system at the end of 14 years. Mr. Pool thought that the proposal to hand the trams over to a company was one of the greatest blunders that the Corporation ever made. In five years every man in that Council would be in favour of getting the trams. If they were to poll the town they would find the majority of the people in favour of their municipalisation. Motions to make the lease terminable at seven or fourteen years were lost. Several other points of detail were agreed upon, and Mr. Russell moved an amendment to the whole proposal, that the Council should adopt the principle of the Corporation making and conducting their own tramway system, but it was lost, and the minutes were passed.

Gilt Lead Accumulator Strips.—The important experiments of Mr. Desmond FitzGerald on the sulphating of lead plates, which led to his invention of gilt lead strips, do not seem to have received the attention they deserve. These experiments, which are described in his patent, can be briefly described. He found that when a strip of lead was placed in contact with peroxide of lead, the active material could be charged by this contact without bad effects developing, but that when the active material was discharged a slight layer of sulphate was always formed, which eventually stopped the action. The second experiment was that when the lead strip was coated by a layer of gilt, however thin, the action of both charge and discharge could go on without any sulphating occurring. This experiment throws an important light upon the theory of the ordinary accumulator. The difference between the FitzGerald experiment and the charge and discharge of an ordinary accumulator seems to be evidently merely one of size of lead surface in contact with active peroxide. The contact surface is very much larger in the case of the ordinary accumulator, but every time the plates are discharged sulphating must occur, and every time this sulphating has to be reduced again. This action eventually destroys the so-called "positive plate." The practical conclusion is that the present system requires an enormous surface of lead to prevent noticeable sulphating, but with gilt lead supports, as proposed by Mr. FitzGerald, the extent of lead surface can be very greatly diminished, and the destruction of the "positive" is stopped. The discovery of the practical method of gilding the lead strips cost Mr. FitzGerald four months of experimental research.

Meters. The case of Bath will very clearly demonstrate the necessity of meters to a supply company. Until recently the electric light in Bath was supplied by contract at a fixed sum per burner per annum, as did the early gas companies. Since there are now several meters which, although not perfect, are sufficiently accurate for ordinary purposes, it has been decided to introduce the system of charging by meter. It is an indication of the greater call for accuracy on the part of electrical engineers, that meters which would pass the gas standard in percentage of error are not sufficiently accurate to be certified by the Board of Trade. Indeed, only one type by one manufacturer, the Shallenberger, has the sanction of the Board of Trade, and this is not to be extended to other manufacturers. No other meter has yet absolutely come up to requirements, it appears, and though there is nothing to prevent companies using that meter which is most accurate, yet until the meters are actually passed, and until a legal standard of current has been adopted, the amount of current sold cannot legally be sued for,

except under agreement to take such and such a meter as correct. Meters, however, are being very widely used with satisfactory results, and the legalisation of the unit cannot be very long in coming. The dissatisfaction of the contract system is twofold, both with him who gives and him who receives—the company and the consumer. For the absence of meter leads to waste of current, and the persons who shut up shop at an early hour, or even 7 p.m., feel they are paying a higher price for the light than the hotels, clubs, and other consumers who keep their light going till midnight. There are several exceedingly good meters on the market, and we hear great things are being said of a meter we described some year or so ago, made by a firm in the North of England, which is to be adopted in an important central station shortly to be started. For all sakes, it is to be hoped the Board of Trade will obtain their legalisation, as they expect, before Parliament meets. Some wonderfully close agreements have been made with the Board's apparatus and the best German standards, and the French electricians are understood to intend to adopt the British legal unit.

Electro-Therapeutics.—We referred in our last issue, p. 348, to an article in our contemporary *Trade, Finance, and Recreation*, and stated that the concluding portion of the article would appear in a subsequent issue of that paper. We have the conclusion before us, and the author of this article very kindly sums up his conclusions, which are (1) that the Harness electropathic belts do generate current; (2) that these currents penetrate the skin; and (3) that the currents in question approximate very closely in strength with homo-electric currents. We must confess still to a lack of conviction. We will not object to the first conclusion, and we do not think that anyone else objects to it. With regard to the second we are at a loss to know how these currents manage to penetrate the skin; and thirdly, we do not quite understand the author's meaning of homo electric currents, nor are we quite sure from his experiments that he ought to designate the currents causing the deflection of his galvanometer as homo-electric currents. It is probably an open secret to some of us that the author of these articles has had an extensive experience in electrical matters, and that the questions which he here discusses have been more or less discussed verbally. In the experiments he describes there are two electric phenomena under consideration, or perhaps three—the body looked upon as a generator, as a conductor, and as a condenser. Had the author been satisfied with merely describing his experiments, and not connecting them in any way with Harness's electropathic belt, more attention would probably have been given to them. We venture to think, however, that this is a mistake, and that the very connection between these experiments and the belts should lead to a closer investigation of what the author says, when probably it will be found that though a repetition of the experiments leads to similar results the interpretation of the causes may be totally different. For some time past we have been endeavouring to arrange for a repetition of the experiments, but, as most people know, when several people are interested in a matter it is difficult to get a meeting at a particular time. We shall therefore leave further comments until we have gone through the whole series of the experiments as described. Any reader who has the use of a sensitive galvanometer can easily conduct the experiments. It would be perhaps satisfactory if a number of them did so, in order to get conclusive evidence on one side or the other.

Fire Risks.—It is fashionable amongst a certain class of electrical engineers to say that fire insurance companies do little but throw obstacles in the way. Speaking in this way is but giving vent to random words and vilifying an important and honourable body of men who are seeking to do their duty to themselves and the public. The more reasonable process would have been, what might still be done with advantage, for these selfsame electrical engineers or others to write a fair and straightforward account of what they considered the duties of an insurance office from their standpoint, with full and sufficient details of electrical work to render the technical knowledge necessary to pass good work easy of attainment. The organ of the fire offices, the *Review*, in the issue of Oct. 5th, takes up the question of electric installation risk in an eminently reasonable spirit. "Slowly but surely a corps of trained surveyors has been formed," says this paper, "*who by practice* are rapidly acquiring a knowledge of the various points involved, and of how many specific dangers revealed can be avoided; but we would warn both the public and the fire offices, that infinitely more depends upon the reputation of the firms engaged in laying on the installation than any survey, however close and searching. If fire surveyors had to test personally each section of every installation put up, it would mean an incredible amount of time and trouble being devoted to the subject. What is really wanted is the formation of a corps of scientific electricians, who shall, at the request of the fire offices, give independent certificates, without knowing or caring for the interests of either the electric firms interested or the fire insurance companies. It shall be their duty to test every apparatus, from the installation of the dynamo up to the last switch. They should not merely have the power, but they absolutely should lift the casing at all joints and test the diameter of the wires. They should require to be furnished with a sample of all the wires laid on, with a statement attached to each wire of the circuit on which it is used, and the power and capacity of the lamps thereon. Switches, fuses, and circuits should be numbered, and samples of the wires and fuses used stuck on a sheet of cardboard; the whole work on a moderate installation would, on such a system as this, not take half a day to accomplish." The *Review* intends to deal more fully with the technical aspect of the case, and it will be very well worth the while of those engineers whose interests are at stake on this question to watch the discussion which will ensue. The statement is added at the close of a thoughtful article that "we are deliberately of the opinion that a properly executed low-tension installation of the electric light is infinitely safer than gas, and most immeasurably better than any kind of lighting by means of lamps or candles." It is hoped the means will be found and regularly administered to protect the safety of the householder, and avoid all extra risk to the insurance companies.

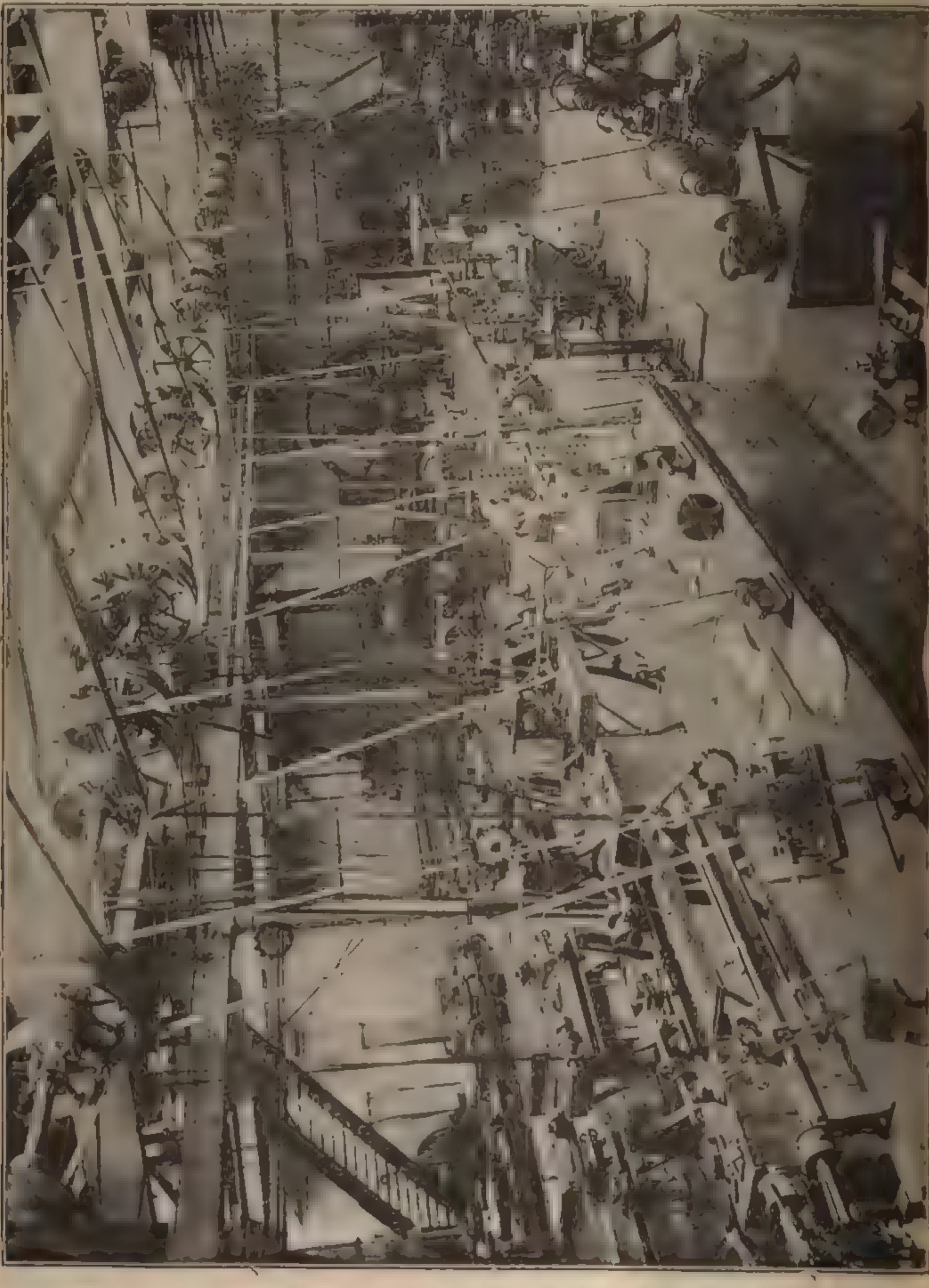
The Goodwin Sands.—There is, says the *Western Morning News*, some prospect of an early establishment of telegraphic communication between the lightships placed on the Goodwin Sands and the shore. Although it is understood that the Trinity masters have yet to report the result of their recent investigations, it was semi-officially stated in a letter received by the Dover Town Council from a gentleman who has for a long time interested himself in this matter, that it had been decided to connect the East Goodwin lightship with Dover and the North Sands Head lightship with Ramsgate. The Trinity masters visited the Goodwin lightships a week or two ago, and took soundings in connection with the proposed scheme. The North Sands Head lightship is about eight or nine miles from Ramsgate, being directly opposite Broadstairs. It is also about equi-distant from Deal as compared with

Ramsgate. The East Goodwin lightship is directly opposite Deal, about seven miles from the shore, whilst the southern extremity of the sands is marked by the South Sands Head lightship, about six miles from Dover, and nearly opposite the South Foreland lights. It is not yet known how the proposed scheme will be carried out, but it is thought that a connecting cable will run between all the lightships, terminating at Ramsgate and Dover. The sands have four lightships, the fourth being the Gull light, in the Gull stream between the sands and what is known as the Brake Sand—running between Ramsgate and Deal. The effect of circuit communication of this character would be that lightships could telegraph for assistance from whichever point wind and sea would permit it to be obtained, as it often happens that, although a vessel in distress is nearer to Ramsgate than to Dover, the direction of the gale would enable the tug and lifeboat to proceed much more easily and quickly from the latter port. Probably there are no "sea-traps" in the world which have so gruesome a record of wrecks as the Goodwins. At low water, although seven or eight miles from the shore, the sands are high and dry, the banks in some places being so sharp in their declivities that vessels run from deep water directly on to the sands. At high water the sea is always disturbed, and in rough weather the roar of the breakers can be heard for a considerable distance. There have been schemes under consideration for coping with the dangers of the Goodwins, but very few of them have been at all practical. One scheme was for the construction of a lighthouse with a sailors' chapel annexed resting on wooden piles in the sands; another was for the making of a harbour of refuge in the sands by encircling what is now known as Trinity Bay, the harbour to be named after the Prince of Wales. This was proposed in 1843, and embraced an elaborate scheme of docks, warehouses, and fortifications. The author of the scheme was Mr. Bush, C.E., and it was estimated to cost a quarter of a million, but it did not meet with any support. The scheme of connecting the lightships with the shore telegraphically is, however, eminently practical, and is probably the only way to reduce the dreadful death-roll of the sands. It will not only ensure speedy communication with the shore, but it will enable directions and instructions to be given of the greatest value to those on shore in going off to rescue a crew. The greatest difficulties to be contended with at present are fogs and snowstorms, during the prevalence of which it is impossible to give signals to the shore, or for a lifeboat to find a ship. It frequently happens that a vessel gets on to the sands in the night during a heavy gale, and is a wreck before any communication can be obtained with the shore, and the same thing happens in snowstorms and fogs. At the present time the masts of the "Hazlebank," a new iron ship on her first voyage, which struck during a fog on the south end of the bank, can on a clear day be seen from Deal above the water.

Catalogue of Central Stations.—It certainly must be a satisfaction to the authorities of a municipality to be able to know a firm to whom they can telegraph "Please supply a central station for 100,000 lamps, plant for 5,000 to start within a fortnight," or words to that effect, as the lawyers say. The catalogue of Messrs. J. E. H. Gordon and Co., Limited, of 11, Pall-mall, takes the standpoint, that the demand for complete central stations is becoming extensive; that they are contractors for central stations, the only large contractors not tied down to any particular system; that they have carried out as engineers or contractors a number of the most important central stations of Great Britain; and that as they are frequently asked for their catalogue the best answer would be drawings and descriptions of the principal works carried out under their superintendence as engineers or by their contractors, with the approximate cost of each. Where the cost of items apiece is some £60,000 or £100,000 this is evidently not easy to do within exact limits, as town requirements differ, but Messrs. Gordon will on receipt of plan of town and particulars, forward within a few days an inclusive price for a station with plant and mains ready for work. The case most likely to occur is when a municipality or company is anxious to start a station and expect that when started it will be largely supported, but at the same time they only wish to spend a small amount to begin with. Special attention is given to this point, and tenders will be given for a complete scheme, together with plan for establishing at first a small portion complete in itself, yet so that the small plant will not need alteration or replacement, but will form an integral part of the whole scheme. The success that has attended the installations already carried out by Messrs. Gordon in England and Ireland are sufficient to demonstrate that the firm are thoroughly reliable and competent to fulfil their promises with complete satisfaction, and the issue of this interesting catalogue of central stations will serve to spread their renown as electrical engineers. The first description, with full-page illustration, is of the old Paddington, G.W.R., central station of 1,900 h.p., which has been at work since 1886, erected under the superintendence of Mr. Gordon. The Manchester-square station of the Metropolitan Company, erected by the Electric Construction Company, to the designs of Mr. Gordon, forms a more modern example of an alternating-current distribution. It has 50,000 lights capacity, and is one of the best-arranged stations in London. Another station of the Metropolitan Electric Company, Rathbone-place, was also rearranged completely to Mr. Gordon's designs. Since the firm became Messrs. J. E. H. Gordon and Co., Limited, several electric light stations have been carried out entirely by them as contractors. Carlow is a well-known example, and is of special interest, as water power is successfully used and transmitted electrically from Milford, five miles away. The Town Commissioners express themselves "highly pleased" with the public lighting. The streets are lighted by 12 arc lamps of 1,200 c.p. and 40 incandescents of 16 c.p., and the plant is capable of supplying, in addition, 1,300 lamps of 8 c.p. to private consumers. The total cost was about £10,000. The total revenue of the Carlow Gas Company is about £1,700, and of this nearly £400 was secured by the electric company in the first six months. An interesting photograph of the Carlow streets is given, and also the station itself, inside and out. At Larne the central station cost £12,000. The town is lighted by 11 Brockie-Pell arcs and 50 incandescents, the system being alternating-current with steam plant. The Town Commissioners are "highly satisfied." Photographs of the plant at this station are shown. Bray, the Dublin Brighton, was lighted for £20,000, the dynamo being driven by water power. There are 117 public lamps—23 arcs and the rest incandescent; and private lighting is also given. The illustration of the Bray station shows clearly the arrangement adopted. The last central station shown is that at Sydenham, which we have fully illustrated in our columns. The contract was for 20,000 light plant for £51,175, and it was completed and the light running in 67 days, 2½ hours before the Press view of the Crystal Palace Exhibition on January 8. Some magnificent reproductions of photographs of the Sydenham plant are given with detail drawings, and it can be seen that this "catalogue of stations" supplies collected information of the greatest interest to public authorities at the present moment.

RONALD A. SCOTT'S WORKS.

We must confess to a good deal of satisfaction during a recent visit to Ronald A. Scott's works at Acton Hill. For



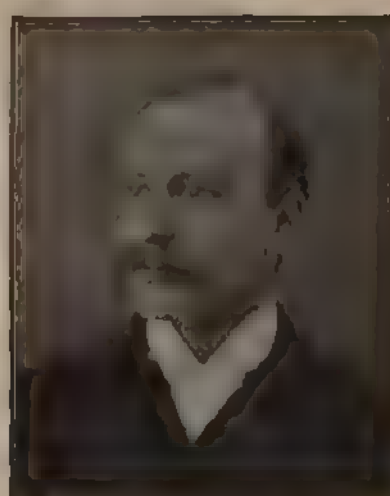
many years past we have been strenuous advocates of factory experience rather than laboratory experience for those who intend making electrical engineering a profession. A combination of the two, however, would be desirable. The mere laboratory student is a somewhat useless animal during the earlier days of his entering into the rough, practical life of an engineer, while the factory worker has his peculiar idiosyncrasies which are not always pleasant. The latter, however, if he has any go in him at all, makes the better man. He is familiar enough with

STEPNEY RAWSON.

PROF. JOHN PERRY.

DESMOND G. FITZGERALD.

JOHN B. VERITY.



W. M. MORDEY.

Among the most recent developments of electrical apparatus by this firm is one in connection with military operations at night, described in our issue of September 16.

Fig. 5.—Positive.

Fig. 6 – Negative.

Still more recent is the perfection of "writing on the clouds." It is well known that for some time efforts have been made by various enterprising people to adapt electric search-light apparatus to advertising purposes. Mr. Ronald Scott has not only attempted the clear throwing of words to a distance, but has succeeded in doing it.

Fig. 4. Hand Lamp.

Some weeks ago we were cognisant of his work in this direction, and have been kept informed of the progress of the experiments which we witnessed on Tuesday night last. For some time before we reached Acton Hill Works we could see the beam of light being turned in various directions. We could also see that the light was distinctly separated into parts, but the night was clear, cold, and starry, with no clouds upon which to throw the beam. So it was not till we got nearer the point of experiment, and could see the beam of light thrown on to distant trees, that we could distinguish the letters. These were clear and well defined, and, of course, proved to be the inevitable "Pears Soap" met with everywhere. The search-light was turned in all directions, and wherever there was a material object upon which the beams could impinge, the words were distinctly seen. Altogether, the experiment was most successful, and, as always is the case, the result, as we were informed, is obtained in a very simple manner; but as the arrangement forms the subject-matter of patents we were prevented from seeing or saying more. Altogether, then, we look upon these works as producing good apparatus of the kind to which especial attention is devoted, and as giving practice and experience to those who desire it, and enter its precincts.

THE LEEDS ARC LIGHT SYSTEM.

Judging by the scant display at recent electrical exhibitions, one is led to the conviction that there are still only two or three important types of arc dynamos for series lighting, and that these have experienced little, if any, improvements during the past few years. In all probability these machines are as perfect as their peculiar design and construction warrants, but it is of the rarest occurrence that results of tests with such dynamos are placed before the public. Of compound wound and shunt-wound dynamos for incandescent lighting or for running arc lights in parallel, there are innumerable types in the market, all claiming the highest possible efficiency. Arc lamps are, as a rule, only used for the lighting of streets, large open spaces, public buildings, and factories possessing lofty rooms. In such cases the distribution of the current to the lamps, if placed "in parallel," involves a capital outlay for copper leads often exceeding in cost the value of the electric generators and lamps combined, even when allowing a very considerable loss of energy in transmission. These facts are well known to electrical engineers, and, wherever possible, "series" arc lighting is resorted to for economic reasons. The following is a short description of a system of series arc lighting evolved by one of the best known engineering firms in the kingdom, Messrs. Greenwood and Batley, of Leeds, who have spared no pains in producing a highly efficient, compact, and economical apparatus. Fig. 1 shows the general arrangement of a 20-light dynamo with the regulating gear attached. By Fig. 2 we can trace the circuit represented in diagrammatic form. The field magnet poles of the dynamo have two small projections, which serve as a magnetic field to a little flat ring armature, M, which is provided with an ordinary commutator and a pair of brushes receiving a weak current through an automatic

reversing switch. This switch consists of an electromagnet energised by the main current, an armature, L, which can make contact with either of the terminals, *a* and *b*, and two resistances, R, consisting of carbon rods about ½in. in diameter and some 6in. long. The slightest variation of the E.M.F. in the main circuit will cause the armature, L, to make contact through *a* or *b*, as the case may be, and send a current through the armature, M, in one direction

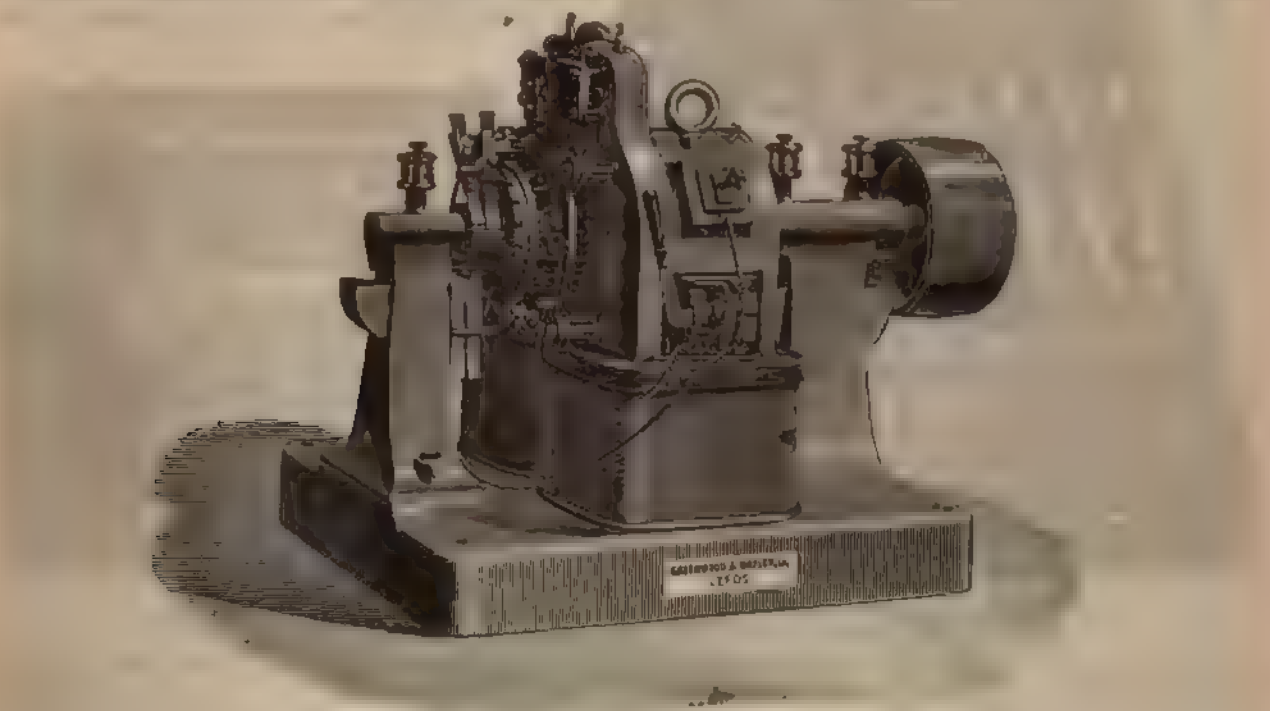


Fig. 1.

or the other, and thus cause the latter to revolve forwards or backwards. By virtue of this rotation of M, the circular rack, S, supporting the brushholders of the dynamo will move slowly (it being driven through a small train of wheels geared to the spindle of M), and thus adjust the position of the dynamo brushes to suit the E.M.F. demanded by any number of arc lamps arranged in series. Contrary to the expectations of some electrical experts, there is no

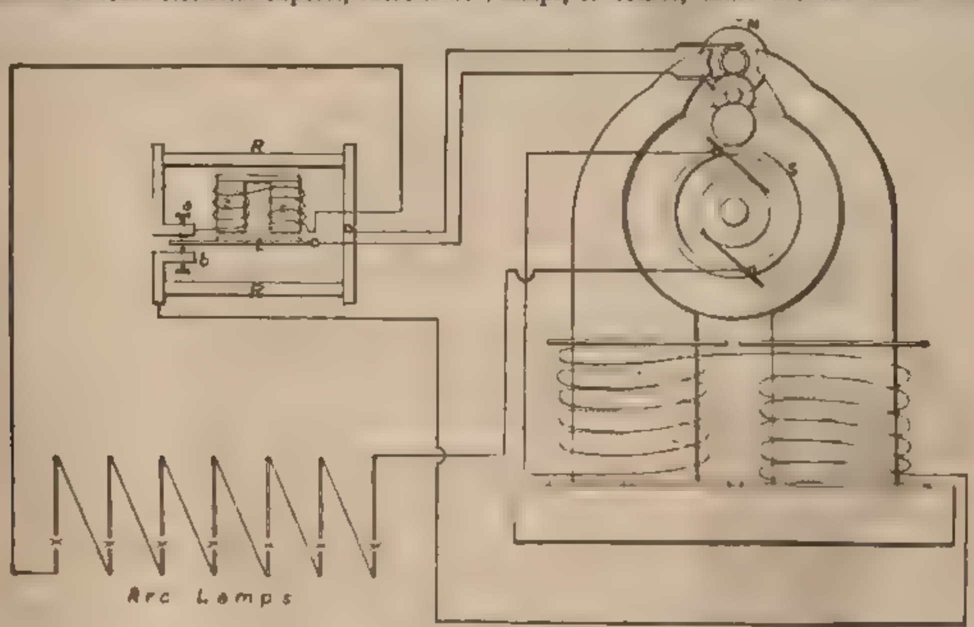


Fig. 2.

"hunting" in the regulating gear—the energy used in actuating it is exceedingly small, and the efficiency of the whole machine at various loads remarkably high. The following tests made on a 20 light machine will show this most clearly. The machine was driven by an electric motor, the brake horse power of which was easily ascertained, running at a constant speed of 750 revolutions per minute. The current was constantly at 10 amperes, and the average voltage measured 47 volts per lamp.

Test of the Leeds Arc Dynamos.

Number of lamps. 2,000 n.c.p.	Speed Revolutions per minute.	Current. Amperes.	Brake h.p. absorbed.
5	750	10	6·31
6	750	10	6·96
8	750	10	7·81
12	750	10	10·65
16	750	10	13·1
20	750	10	15·2

The regulator absorbs only 21 watts, or about ¼ per cent. of the maximum load—quite a negligible quantity. There is no sparking at the contact-maker, and when once adjusted the automatic regulator will act promptly and without any further attention, except an occasional dusting. By the Leeds arc light system it is possible to run incandescent lamps in series with arc lamps. Such incandescent lamps, of course, must use the same current as the arc lamps, and they are fitted with holders and switches, to be put in and out at will. The economy, simplicity, and utility of having both arc and incandescent lamps run in series from the same dynamo will be appreciated, especially in such cases as the lighting of mills, factories, and public halls, where the greater part of the lighting is done by means of arc lamps, but where a few incandescent lamps would be useful in offices and rooms forming part of the premises.

Title of Order.	To whom granted.	Revoked or repealed.
Edison and Swan United Electric Lighting Order, 1884.	Edison and Swan United Electric Light Co., Ld.	*
St. James, St. Martin, and St. George's, Hanover-square (West London) Electric Lighting Order, 1884.	West London Electric Lighting Co., Ld.	Revoked Feb. 4, 1887.
	1886.	
Chelsea Electric Lighting Order, 1886.	Chelsea Electricity Supply Co., Ld.	—
	1889.	
Birmingham Electric Light and Power Order, 1889.	Messrs. Arthur Chamberlain and George Hookham.	—
House-to-House Electric Light Supply Order, 1889.	House-to-House Electric Supply Co., Ld.	—
Kensington and Knightsbridge Electric Lighting Order, 1889.	Kensington and Knightsbridge Electric Lighting Co., Ld.	—
Liverpool Electric Lighting Order, 1889.	Liverpool Electric Supply Co., Ld.	†
London Electric Supply Corporation Electric Lighting Order, 1889.	London Electric Supply Corporation, Ld.	—
Metropolitan Electric Supply Company (Mid-London) Lighting Order, 1889.	Metropolitan Electric Supply Co., Ld.	—
Metropolitan Electric Supply Company (West London) Lighting Order, 1889.	Do. do.	—
Notting Hill Electric Lighting Order, 1889.	Notting Hill Electric Lighting Co., Ld.	—
St. Martin Electric Lighting Order, 1889.	The Electricity Supply Corporation, Ld.	—
South Kensington Electric Lighting Order, 1889.	Chelsea Electricity Supply Co., Ld.	—
Swansea Electric Lighting Order, 1889.	The Corporation.	—
Westminster Electric Lighting Order, 1889.	Westminster Electric Supply Corporation, Ld.	—
	1890.	
Aberdeen Electric Lighting Order, 1890.	The Corporation.	—
Accrington Electric Lighting Order, 1890.	Do.	—
Ashton-under-Lyne Electric Light and Power Order, 1890.	Municipal Electric Light and Power Corporation, Ld.	Revoked Aug. 20, 1891.
Ayr Burgh Electric Lighting Order, 1890.	The Corporation.	—
Bacup Electric Lighting Order, 1890.	Do.	—
Barnsley Electric Lighting Order, 1890.	Do.	—
Bedford Electric Lighting Order, 1890.	Do.	—
Belfast Electric Lighting Order, 1890.	Do.	—
Birkenhead Electric Lighting Order, 1890.	Do.	—
Blackburn Electric Lighting Order, 1890.	Do.	—
Blackpool Electric Lighting Order, 1890.	Do.	—
Bognor Electric Lighting Order, 1890.	The Electric Trust, Ld.	—
Bournemouth Electric Supply (Brush) Order, 1890.	Brush Electrical Engineering Co., Ld.	—
Bournemouth Electric Supply (House-to-House) Order, 1890.	South of England House-to-House Electricity Co., Ld.	Revoked Jan. 18, 1892.
Burnley Electric Lighting Order, 1890.	The Corporation.	—
Burton-on-Trent Electric Lighting Order, 1890.	Do.	—
Bury Electric Lighting Order, 1890.	The Corporation.	—
Cambridge Electric Lighting Order, 1890.	Do.	—
Chatham, Rochester, and District Electric Lighting Order, 1890.	Chatham, Rochester, and District Electric Lighting Co., Ld.	—
Cheltenham Electric Lighting Order, 1890.	The Corporation.	—
Chester Electric Lighting Order, 1890.	Do.	—
Coatbridge Electric Supply Order, 1890.	Scottish House-to-House Electricity Co., Ld.	—
Darlington Electric Lighting Order, 1890.	The Corporation.	—
Derby Corporation Electric Lighting Order, 1890	Do.	—
Dover Electric Lighting Order, 1890.	Do.	—
Dundee Electric Lighting Order, 1890.	The Gas Commissioners.	—
Eastbourne Electric Supply Order, 1890.	Eastbourne Electric Light Co., Ld.	—
Fleetwood Electric Lighting Order, 1890.	The Improvement Commissioners.	—
Galway Electric Lighting Order, 1890.	John Perry, James Perry, and James Edward Pearce, trading as the Galway Electric Co.	—
Glasgow Corporation Electric Lighting Order, 1890.	The Corporation.	—
Great Yarmouth Electric Lighting Order, 1890.	Do.	—
Hastings and St. Leonards-on-Sea Electric Supply Order, 1890.	Hastings and St. Leonards-on-Sea Electric Light Co., Ld.	—
Hastings (Public Purposes) Electric Lighting Order, 1890.	The Corporation.	—
Hove Electric Lighting Order, 1890.	The Hove Commissioners.	—
Huddersfield Electric Lighting Order, 1890.	The Corporation.	—
Kelvinside Electric Lighting Order, 1890.	Kelvinside Electricity Co., Ld.	—
Kingston-upon-Hull Electric Lighting Order, 1890.	The Corporation.	—
Lancaster Electric Lighting Order, 1890.	Do.	—
Leicester Electric Lighting Order, 1890.	Do.	—
City of London Electric Lighting (Brush) Order, 1890.	Brush Electrical Engineering Co., Ld.	—
City of London (East District) Electric Lighting Order, 1890.	Laing, Wharton, and Down Construction Syndicate, Ld.	—
Crystal Palace and District Electric Lighting Order, 1890.	Electric Installation and Maintenance Co., Ld.	—
Lambeth Electric Supply Order, 1890.	House-to-House Electric Light Supply Co., Ld.	Revoked Jan. 29, 1892.
London Electric Supply Corporation Electric Lighting (Metropolitan) Order, 1890.	London Electric Supply Corporation, Ld.	—

* This order authorised the transfer to the Edison and Swan United Electric Light Co., Ld., of the powers, etc., granted by the following orders—viz., St. James's and St. Martin's (London) Electric Lighting Order, 1883; Hanover-square District (London) Electric Lighting Order, 1883; South Kensington Electric Lighting Order, 1883; Strand District (London) Electric Lighting Order, 1883; Victoria District (London) Electric Lighting Order, 1883. These orders have since been revoked.

† The Liverpool Electric Lighting Order, 1892, scheduled to the Electric Lighting Orders Confirmation (No. 4) Bill, now before Parliament, contains a provision for the repeal of this order.

(To be continued.)

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CONTENTS.

TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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NOTICE.

With this issue of the Paper is given a Supplement containing Portraits, taken from photographs, of **Prof. John Perry, Mr. Desmond G. FitzGerald, Mr. Stepney Rawson, Mr. J. B. Verity,** and **Mr. W. M. Mordey.**

Every reader should see that he gets this Supplement, and non-delivery with the Paper should be reported at the Publishing Office.

THE "BELFAST EVENING TELEGRAPH."

It is not often that we have to mete out unstinted praise towards our political contemporaries. Too often they do much harm to an industry they do not understand, and fill their readers with a kind of information that is more than misleading, being absolutely contrary to truth. The great London dailies seem to take every opportunity of giving tongue and credence to the most astonishing rumours from the Continent or America. It is, therefore, a pleasing surprise to find the *Belfast Evening Telegraph* sending a special commissioner to London in order to examine and report upon the electric lighting as represented in the metropolis. The special commissioner has contributed at least eight long articles to his paper, and, with one peculiar exception, has gathered together information that should at least assist in educating the citizens of Belfast in matters electrical. Of course these articles can hardly be classed as technical. They contain erudite and recondite allusions to men and manners outside the pale of the electrical industry, and the commissioner seems to have been satisfied with discussing three or four typical installations. By far the greatest space and attention is given to the work of the Brush Company, not only in connection with its work at Bankside for the public lighting of the City, but also in regard to its general and, if we may say so, its historical work and future policy. The last information seems a little out of place, though in a measure it is advantageous to refer to it. Let us explain. In article No. 4 we have the following: "In common with all other compaies here, the Brush Company labour under a disadvantage in not being able to manufacture the glow lamp, but they are eagerly looking forward to the happy time—I believe November next year—when the Edison patent will lapse, and when there will be no restriction upon the progress of domestic lighting." Now we hardly take the remarks made in these eight articles as the spontaneous utterances of the commissioner. He has naturally been flooded with information and with the opinions of his hosts, and has, to a greater or lesser extent, reproduced the opinions given in his hearing.

Is it not, then, a mistaken policy for the Brush or any other company to rail against the working of the patent law? They are earnest enough in claiming all their rights in connection with their own patents and in proceeding against infringers, and cannot for a moment contend that they have not endeavoured to make as much profit as possible out of the patents they control. Why, then, should Edison, or Swan, or Sawyer be more or less held up to opprobrium because they are the holders of certain patents which give them the monopoly of manufacturing incandescent lamps? Surely the Brush Company would not wish to see the patent laws abrogated. They, through the commissioner of the *Belfast Evening Telegraph*, seem to hint that patents are wrong, and whenever or wherever anything is discovered and patented it is a mistake to give the discoverer a monopoly, and to disallow for fourteen years any man or firm making the articles so dis-

covered. It may be, however, that our interpretation of these remarks is incorrect, and that all that was meant was to indicate that ere long the cost of the lamp would probably be lessened, and to hold this out as an inducement to carry out an electric lighting project in Belfast. The cost of renewals of lamps, as well as initial cost, is indeed an item to be considered, but it is not of sufficient gravity to be made rank as a disadvantage to the Brush and every other company. The inability to make lamps is no more a disadvantage to the Brush Company than the inability to make Mordey alternators is a disadvantage to Brown, Jones, and Robinson. Let us put in an aside; like our contributor, Mr. Ansell, we intensely dislike the term glow lamp, and prefer to use incandescent, but the commissioner has been primed with "glow," and glow to him it must be. Descriptions are given of the lighting of clubland, of the St. James's installation and district, of the gigantic Deptford installation, and of St. Pancras. The commissioner falls into some error in his description of the Deptford installation. He assumes or has been told that Ferranti's gigantic machines are running, but that is not so. Otherwise, as we have said, the information given is fairly accurate, and such as should give the readers of the said paper a fair idea of what is being done in London.

CORRESPONDENCE.

"One man's word is no man's word.
Justice needs that both be heard."

TRANSFORMER DESIGN.

SIR,—In your issue of the 7th inst. is an article by M. F. Géraldy, entitled "Transformers made by the Société l'Eclairage Electrique." In this article M. Géraldy appears to be under the impression that the rule of thumb is still the principal factor in the design of alternate-current machinery, and cites as an instance the Lauffen-Frankfort experiments, where the generating machine designed for 300 h.p. is represented as only giving 120 h.p.

M. Geraldy appears not to have read the results of the tests made by the committee of the Frankfort Exhibition, in which the machine was loaded to 200 h.p., when it gave a commercial efficiency of 93·5 per cent. It was impossible during the exhibition to test the machine on full load owing to the absence of a suitable resistance at Frankfort. As a matter of fact, the same machine is now supplying current for the lighting of the town of Heilbronn, situated about six miles from Lauffen, and its output during the period of greatest demand attains 300 e.h.p.

For my part, I consider that many of the theorists do not sufficiently understand the conditions involved in the actual design of alternate-current machinery to render them competent critics.—Yours, etc.,

C. E. L. BROWN

OUR PORTRAITS.

FitzGerald, Desmond Gerald Manners, to give his baptismal name in full, was born in February, 1834, at Parliament-place, Westminster. His father, Edward Marlborough FitzGerald, at one time private secretary to his cousin, Lord FitzGerald and Vesey, president of the Board of Control, was well-known in literary circles. His mother (Charlotte Julia), who still survives, is the elder daughter of the late Sir Richard Mounteney Jephson, judge-advocate at Gibraltar, whose younger daughter is the present Dowager Marchioness of Ailsa. Sir Richard's surviving son, the present baronet, is General Sir Stanhope Jephson, C.B., who served with distinction in India under his uncle, Lord Keane, commander-in-chief. Thus, the subject of our present notice, a godson of John Forster, and brother-in-law of the late General the Right Honourable Sir Thomas Montagu Steele—who for some years commanded her Majesty's forces in Ireland—belongs to a literary and military family; none of whom, it may be said, had any sympathy with his taste for science in general and electrical applications in particular. Mr. FitzGerald's personal reminiscences of the literary celebrities who visited at his father's pretty house, Elmstead, near Bromley, might be very interesting in a literary journal, but would be out of place here. At the age of 13 he was placed at a school in Vincennes connected with the University of France. The events in Paris of 1848 produced a strong and lasting impression upon his mind. Returning to England at the close of 1850, he spent some years in making acquaintance with English society, and in fits of somewhat desultory study. The lectures on chemistry of Robert Hunt, at the School of Mines, first turned his attention to this science. The *res angusta domi* at length led to his accepting an appointment in the Colonial Land and Emigration Office, under the late Sir Stephen Walcott. Here, with his continental notions of behaviour and etiquette, he found himself entirely out of place, and in about a year accepted the position of assistant secretary to the Submarine and European Electric Telegraph Company, then located at 30, Cornhill. Here he made the acquaintance of Mr. France, the engineer to the company, and also of Mr. Bakewell, the inventor of the copying telegraph, and of that extraordinary genius, Alexander Bain, who was employed "as a workman" by Sir Charles Wheatstone. At the instance of his friends he left the Submarine Company to take up an appointment at the Legacy Duty Office, Inland Revenue, where he held her Majesty's commission. In three years' time, however, disgusted with the behaviour of the then Comptroller of Legacy Duties, he resigned his appointment, and maintained himself for some years by literary work. At this time he made the acquaintance of Mr. Healey, of the *Engineer*, and commenced to write for that paper, which still, we believe, considers Mr. FitzGerald as a member of the staff. He also established a laboratory, and commenced in earnest the experimental study of electricity, as well as of chemistry. In this pursuit he received no encouragement; but his friends obtained for him, and induced him to accept, an appointment in the Store Branch of the War Office, Pall-mall. Here he remained during the period of Sydney Herbert's tenure of office, and for some portion of that of Major-General Peel. But his mind was too earnestly devoted to scientific studies to allow of his giving his time to the routine duties of official work. About the end of 1861 he resigned this appointment in order to start the *Electrician* (old series), which may be said to be the first paper exclusively devoted to electricity. This paper was continued under many difficulties and discouragements, until May, 1864; after that period, he wrote frequent articles for several of the technical papers, and was for some time editor of the *Electric Telegraph Review*. Mr. FitzGerald was lecturer and examiner at the School of Telegraphy and Electrical Engineering from its commencement until it passed into the hands of the late Dr. Lant Carpenter. Many of the foremost among the rising generation of electricians received their first technical instruction from his lectures. As most of our readers are aware, Mr. FitzGerald is still working energetically on various practical problems of electro-chemistry—*e.g.*, secondary batteries, standards of E.M.F., and electrolytic production of "bleach" and alkali.

Perry, Prof., John, M.E. (Master of Engineering), **D.Sc., F.R.S., Assoc.M.I.C.E.** Born at Garvagh, a town in Ulster, in 1850. His earlier education was obtained at the Model School in Belfast. An account of his life from that time to this is almost or quite a description of constant successes in everything that he has touched. He gained prizes at school, on matriculation, and in college. He gained Whitworth Exhibitions in 1868 and 1869, and a Whitworth Scholarship in 1870. This was after serving an apprenticeship to the firm of Messrs. Coates, of the Lagan and Prince's Dock Foundries, Belfast. His

career after leaving tended educationally, and he went to Clifton College as lecturer in physics. During his stay there he published an excellent "Elementary Treatise on Steam." Leaving Clifton, he became Thomson Scholar and hon. assistant to Sir Wm Thomson in Glasgow, during which time he was constantly employed in literary work. In 1875 he went to Japan as joint professor of engineering, and returned to England in 1879 Some of our readers may recollect that so energetic was Prof. Perry, with his other professional colleague in Japan—Prof. Ayrton—that at one time it seemed as if the hub of the scientific universe had migrated from England to Japan. The scientific papers of these colleagues are very voluminous. On returning to England, he at first associated himself with Messrs. Clark and Muirhead, but the leaning towards the literary and educational proved too strong, and, in 1882, he became professor of mechanical engineering at the Finsbury Technical College. Since then, Prof. Perry has added to his reputation as an admirable lecturer and as a sound scientist. In June, 1885, Dr. Perry was elected a fellow of the Royal Society. If his energy continues to be as active in the future as it has been in the past, we should be afraid to say how many columns of the Royal Society's catalogue this indefatigable writer and investigator will at length appropriate under his own name.

Mordey, Wm. M , M I.C E., was born in 1856, and at the early age of 14 entered the Postal Telegraph service, in which, after serving a short time in London, he was removed to Bradford, in Yorkshire. Like most other men who have made their mark in the sands of our time, Mr. Mordey, while pursuing his ordinary avocations, was anxious to perfect himself in the theory of the subjects in which he was practically engaged, and devoted a considerable time to study. That his knowledge in this direction was successful is seen by the fact that he was asked to organise and conduct classes for the study of electricity and magnetism, in which he was very successful. In 1881 he left the telegraph service for electrical engineering in the broadest sense, and went as electrician to the Brush Company, with which company he has remained ever since, and from the first his talents asserted themselves. He commenced with the Brush Company as superintendent of the testing department, but was ere long advanced to be the electrician of the company. As most of our readers know, Mr. Mordey's papers, which have been contributed to various societies, have been of the greatest practical character. He devoted his attention to the perfecting of the machines as constructed by the Brush Company with great success, till his name has become a household word amongst those who are engaged in constructing dynamos. For a paper by him on "Some Prejudicial Actions in Dynamo Machines," read in 1884, he received the honourable mention of the Council of the Society of Telegraph Engineers In the same year he described, before the Institution of Civil Engineers, the methods and constructions that are best adapted for working compound dynamos of similar, as well as unlike, size, powers, or speed, in parallel circuit. To the *Philosophical Magazine* for January, 1886, he contributed an article on "The Dynamo as a Generator and as a Motor · Some Analogies and Contrasts,' in which some experiments and observations, made by himself and Mr. C. Watson, were described that threw something more than doubt upon many of the views that had generally been held with regard to electric motors. The conclusions arrived at in this article have passed into general practice, although at the time they were diametrically opposed to the teaching of well known authorities on the subject. At the British Association meeting of 1886 he read a paper and showed some experiments on "An Electric Motor Phenomenon," illustrating very forcibly some effects of self-induction. In the same year, before the South Wales Institute of Engineers, he read a paper dealing with the subject of the possibility of explosions in fiery mines with incandescent electric lamps. In 1887 he was engaged at the Victoria Works of the Brush Company on his "alternator," an alternating current dynamo of a new type, which, together with his transformer and other apparatus, have been successfully introduced by the company under the title of the Mordey-Victoria alternate-current system. This system is now being used for general lighting in about 50 towns abroad and at home. Amongst other important places, it is now being installed for the lighting of the central and western districts of the City of London. Mr. Mordey was in 1888 elected as associate member of Council, and in 1890 a member of Council of the Institution of Electrical Engineers, before which Institution in 1889 he read an important paper on "Alternate-Current Working," dealing with many branches of the subject, and especially with the principles underlying the best construction of alternators for the purpose of parallel working and for synchronising motors. For this paper he received the Institution premium of the year. In 1891 he visited the United States, mainly to examine the systems of electric traction in use in that country. He is a member of the Physical Society and of the American Institute of Electrical Engineers. He is on the Electricity Committee of the Royal Commission for the Chicago Exhibition of 1893.

Rawson, Stepney, M A. Born 1854, educated at Westminster School (where he was captain 1873), and Christ Church, Oxford, where he took honours in the mathematical schools—B.A. 1877, M.A. 1880. After leaving Oxford, Mr. Rawson devoted himself for five years to scholastic work, but being compelled by ill health to relinquish this, he joined the firm of Woodhouse and Rawson in 1882 He was associated with the development of the firm's incandescent lamp business, and in connection with it he applied himself to the question of standards of light, which resulted in the firm undertaking the manufacture of Mr A. V. Harcourt's Pentane Standard lamps. He also, at this period, was employed in the investigation of the Welsbach incandescent gas lamp, and was the originator and patentee of the method by which the fragile incandescent bodies were rendered portable, thus overcoming the principal difficulty connected with the system. Since 1887 Mr Rawson has been engaged by Woodhouse and Rawson as technical expert to report upon the various processes brought under their notice. He was, in his earlier days, well known as an athlete, and is now an ardent lacrosse player. He has been heard more than once at the concerts of the Electro-Harmonic Society He is a member of the Institution of Electrical Engineers, and other scientific societies.

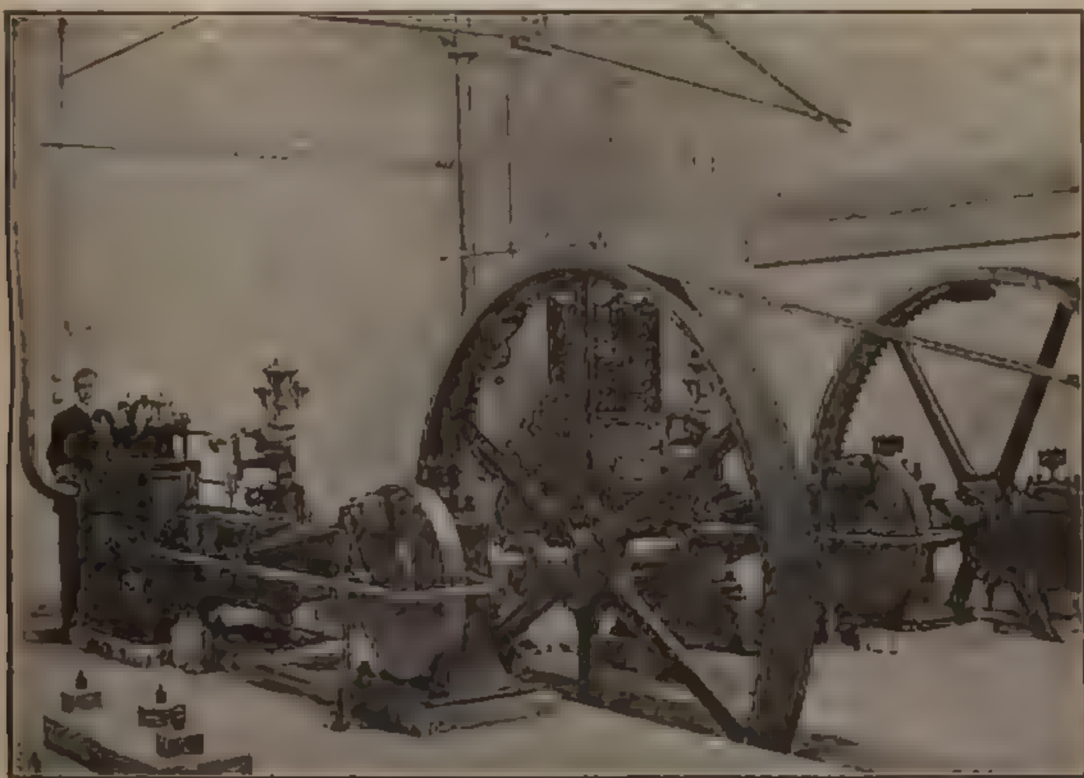
Verity, John B, born in 1864, as is well known, is one of the firm of Verity and Sons, King street, Covent Garden, whose works are known as the Plume Works, Aston, Birmingham. Mr. Verity, although young, has won his spurs in the business world, and if the foresight and energy he has put into the development of the electrical part of his business continues, the firm will take a still higher rank in the industrial world. So much are the business instincts of Mr. Verity valued that he is a director of the Metropolitan Company, the Electric Construction Corporation, the Nassau Steam Press, the British Chemical Company, and senior of Messrs. B. Verity and Sons But Mr Verity has other obligations besides those of business, and is an active politician, being the president of the Aston Liberal Association. He is also an income-tax commissioner, so that his life may safely be said to be a busy and a useful one. Some years ago Mr Verity travelled over a great part of South Africa, but latterly his avocations have left him less leisure, and his trips are restricted to the States. He is the author of a popular book on electricity.

ABERDEEN ROYAL INFIRMARY.

This installation has been made and erected to the specification and under the supervision of Prof Jamieson. It consists of two safety Babcock and Wilcox multitubular boilers, of 100 h p. each, working at a normal pressure of 120lb. per square inch. The boilers are fed with feed water by Messrs. J H Carruthers and Co's duplex pumps either direct or through a special feed water heater (supplied by the boilermakers), and a complete range of Messrs Green and Sons' fuel economisers. This provides that the feed-water shall be raised in temperature considerably above ordinary boiling point before it enters the

boilers, thus ensuring economy and freedom from stresses in the tubes. The feed-water as it passes through the heater is heated by the exhaust steam from the engines, and on its passage through the Green's economiser by the waste gases from the furnaces as they pass from the boilers to the chimney. The steam for use within the infirmary buildings proper is reduced in pressure by means of Auld's patent reducing valves, so as to prevent danger, but that for the electric light engines is conveyed direct to them at full pressure by specially strong cast-iron and copper pipes made by the boilermakers, and by Messrs. Abernethy and Co., of Ferryhill. All steam and hot-water pipes within the boiler and engine rooms have been thoroughly lagged by Messrs. Wormald and Co.'s fibrous non-conducting material, in order to prevent condensation, and thus tend to the saving of fuel.

Engines and Dynamos.—For the purpose of driving the two Castle dynamos, there have been fixed on very solid foundations, prepared by Mr. Kelly, the architect, two horizontal engines by Messrs. Marshall and Sons. These engines are fitted with Dr. Proel's patent automatic cut off gear, controlled by a sensitive governor, whereby steam is



Engine Room at Aberdeen Royal Infirmary.

admitted in proportion to the load, and their speed kept practically constant at 96 revolutions per minute. Broad orange tan belts, by Messrs. Tullis and Co., of Glasgow, connect the flywheels of each engine with its corresponding dynamo. The belts may be eased or tightened at pleasure, either whilst the machinery is standing, or in motion, by horizontal screws, which push or pull the dynamos on their foundation rails towards or away from the engines The dynamos, as well as the whole of the electrical plant and fittings, have been made or supplied and fitted up by Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne, who also had the contract for the engines and storage cells. The dynamos are of the high-resistance shunt type. They are so coupled up that they can be used either for lighting the incandescent lamps direct, or for charging the storage cells, or for working in conjunction therewith as occasion may require. When used for direct lighting, they deliver the electrical energy at a constant pressure of 100 volts when running at 720 revolutions per minute, but when charging the accumulators, the pressure is generally 135 volts, to overcome the back E.M.F. of the cells. Each engine and dynamo is capable of supplying 240 amperes, or of lighting the whole of the lamps throughout the building, so that there is in effect not only a complete duplicate plant, but also a reserve of power in the storage cells for use during the very late and early hours, when the engines may be stopped, or in case of anything going wrong with them and the boilers. Foundations have already been laid for a third engine and dynamo, which will light the old buildings now undergoing internal structural alterations.

Switchboards.—The current from the dynamos and the accumulators is conveyed first to a switchboard situated in one corner of the engine room, where the electrical pressure is registered by Lord Kelvin's multicellular voltmeter, and the quantity of current by J. H. Holmes's patent ammeters. It is there distributed by means of Castle quick break switches, and sent through safety fuses to the subsidiary switchboard fixed opposite the day and night porter's room, where it can be turned on to or off from the different sections of the building as required.

Leading Wires and Lamps.—Throughout the whole of the surgical block, laundry, etc., there have been fitted up, in specially prepared canary wood grooved casings, several miles of highly insulated cables and leading wires These cables and leads convey the current from the subsidiary switchboard to the various lamps of which there are over 400 ranging from 8 c.p. to 150 c.p. each, according to their position and use. For example, eight-candle lamps have been fitted into small closets, and the portable lamps for bedsteads, etc.; 16-c.p. lamps for ordinary lighting throughout the building and 150 c.p. lamps for the operating-theatres, also engine and boiler rooms. Each bed is not only fitted with a reading and a portable light for examining patients, but also with wall attachments, so that the special electro-medical appliances (so useful in certain treatments of disease) may be affixed thereto, and manipulated with ease as well as freedom from danger. In the oculist department a dark room has been provided, with a universal motion bracket, and reflectors for concentrating or for reflecting parallel rays.

Accumulators.—In such an installation as this at the Royal Infirmary, the arrangements would not be complete without storage cells, whereby current may be obtained of any desired pressure at any time during the day or night, either for lighting or for medical use. The last pattern of the Electric Power and Storage Company's cells (or K type) are installed. They are situated in a compartment by them-

selves at the end of the dynamo-room. This compartment has been specially ventilated so as to carry off the gases generated during charging.

Electrical Plant Buildings.—The architect (Mr. Kelly) has carried out in a most substantial manner the general requirements for space and arrangement of plant demanded by the consulting engineer.

During the progress of the works Mr. Norman Whitelaw, a former student of the Glasgow and West of Scotland Technical College, has acted as electrical and mechanical inspector under Prof. Jamieson.

The engine and boiler rooms, together with all machinery, etc., cost over £8,000.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.*

BY PROF. GEORGE FORBES.

LECTURE III.

(Continued from page 359.)

The machines which are at our disposal with alternating currents are enormously varied in character. First, let me speak a few words about the ordinary continuous-current motor with a commutator. When we use alternating currents with them, of course it is essential to have the field magnets laminated, or made of sheets of thin iron, in order to prevent the waste due to the formation of eddy currents—Foucault currents, as they are called—in the iron of the field magnets. Even then the machine will not work with the alternating currents of high frequency; but I stated in my last lecture that it is practically certain that when we come to the future of alternating current distribution we shall be dealing with very much lower frequencies than we have been dealing with in the past. With low frequencies such continuous-current motors will work extremely well. As I said in my last lecture, referring to this question, an ordinary 10 h.p. continuous-current motor with laminated fields, made for 100 volts, would, owing to the self induction of the circuit, have its output reduced about 50 per cent., because 100 volts being required for working the armature, another 100 volts would be required for getting over this self induction; whereas, if we reduce the frequency of alternation down to the frequency which occurs in the armatures of ordinary continuous-current machines, we should only be using six volts out of 100 for this purpose; so that we might say that it is within the range of practical working. Simply for distribution in a town, if the question were asked at this present moment, it is quite possible that it is this type of motor which it would be most desirable to use. The reason is that this motor, arranged for alternating currents by having its field magnets laminated, is able to do exactly the same work as the continuous-current motor is at the present time, that is to say, it is able to be stopped and started as frequently as you please with the utmost convenience, and, moreover, it has the enormous advantage of producing greater force tending to turn it at the moment when we start it, than when it is running at its full speed. The very fact of your having a larger current going through it at the start magnetises the field magnets to a greater extent and increases the turning force—the torque—which is moving it. That is a particularly desirable thing in the case of machinery in workshops and so on; but, of course, it is of the greatest importance in the case of our tramcar motors. All tramcar motors at the present time use continuous currents, but, if we were wishing to use alternating currents, it is quite probable that at the present moment this type of motor would be the most suitable and most readily available, and it is more in working tramcars and electric railways that we find the tremendous want of a powerful starting torque—that force at starting, and where the value of the series-wound continuous current motor is so great. That advantage would be reaped also by the same type of motor used with alternating currents.

I have spoken about the possibility of using alternating currents for electric railways and tramways. You might say that there is no advantage in using alternating currents for that purpose; but when we come really to examine the practical cases, such practical cases as are before the engineering world at the present moment, looking at the experience of the South London Electric Railway and looking at the Central London Electric Railway which is being planned for at the present moment, and looking at the half-dozen other lines for which there are Bills in Parliament at this moment, we find that the alternating current possesses a very great advantage over the continuous current. When we are carrying our conductors to great distances, as in the Central London Railway, for instance, a distance of many miles, just as the South London Railway generating station is miles distant from other parts of the line, we find that in continuous-current working at only some 400 or 500 volts we have an enormous loss in our leads, and we have an enormous expenditure of copper in our mains going to these distances. Here our conductors are not buried underground. The expense of laying our conductors is not, as in the case of electric lighting generally, the expense of going underground, and getting round pipes, and getting over other difficulties. Our expense in conductors here is simply in the copper which we put into them. Now, here we have the total gain which the alternating current is able to give us. It is altogether gain here, and if we are able to carry the alternate current by means of high tension over this long distance, and to transform it by means of that most efficient appliance, the alternating-current transformer, down to lower pressures at the place where it is required for working the tramcar or the locomotive, in that case the alternating current will be giving us an enormous advantage over the continuous current. Consequently, it is extremely likely that the alternating current will be adopted in some of these schemes, which are actually before engineers at the present moment, and if such a scheme had to be worked by the alternating current at this very moment, I think that it is extremely probable that we should use alternating currents at very low frequency, alternating some five or ten times per second, using high tension in the mains, and low tension in the secondaries, and using the very continuous-current machines with laminated field magnets that I have been speaking of for the purpose. That is, at the present moment, probably the solution that would be best, but the improvements and advances which are being made in the use of the alternating current with motors are so enormous that I would not say that in a few months the facts may not be different.

I wish now to say a few words about a type of machine which has attracted considerable attention in the past, and which for certain purposes is probably the best that can be used—that is, the synchronising alternating-current motor. This is simply an ordinary alternating-current machine, a dynamo machine for producing alternating currents. It is put upon the circuit and made to work as a motor, and it works as a motor when once you have given it its necessary speed. The motor must be going at the same speed of revolution as the generator of the electricity, otherwise this type of motor will not work.

It has been somewhat of a puzzle to a great many engineers—certainly it has been a great puzzle to the "practical" man that I was speaking of a short time ago—to understand what was the reason that some alternating-current dynamos worked so well as motors and some did not. I think the question has been rendered, perhaps, a little more puzzling by the explanation having been so completely given in certain cases by Dr. Hopkinson. Dr. Hopkinson, some years ago, read a paper before the Institution of Civil Engineers, in which he showed that the self induction which is inherent in the alternating-current machine tends to keep together the two machines when they are acting as generator and motor, and prevents them from getting out of step, and that, therefore, there is a certain amount of power which can be transmitted from the generator to the motor, and the motor can be made to do work. He elaborated this in an extremely interesting paper before the Institution of Electrical Engineers. As soon as these facts were established, a number of the so-called "practical" men immediately set to work to make machines with as much self induction as they possibly could, and they altogether defeated their aims

* Cantor Lectures delivered before the Society of Arts.

The astonishment of many of these men was very great when Mr. Mordey read his most valuable paper—also before the Institution of Electrical Engineers—in which he showed that his dynamo machine, in which there is very little self-induction, and in which there is no iron in the stationary armature, works as a motor most admirably. He gave results which had never been excelled by any alternating-current motor that had been tried, and yet there was very small self-induction in the machine at all. This was rather a puzzler for such men; and, finally, the puzzle was complete when a comparison was made between such a machine as the Siemens alternator, which you all know, and the Mordey alternator. The Siemens and the Ferranti are both the same. The only difference between the Siemens or Ferranti alternator and the Mordey alternator is that, in the one case, the armature revolves, and in the other case the field magnets revolve; otherwise they are practically identical, from an electrical point of view. Yet the Mordey alternator acts most admirably as a motor, and the Siemens or Ferranti machine does not work as a motor. The reason is simply this, that the power which is being given to an alternating motor is of course of a pulsating character, like the current; and there are moments when no power is given to the motor at all. If, then, the motor is doing work, it requires to have a considerable momentum to get over those dead centres, and to be able to continue doing the work, and to get past those dead centres when the generator is giving out no power whatever. Now, the Mordey alternator, in which the field magnets rotate, has an enormous momentum; but the Siemens or Ferranti alternator, where the armature rotates, has very little momentum indeed; and the consequence is that while the Mordey alternator works admirably as a motor, the Siemens or Ferranti alternator does not. All you have to do with the Siemens or Ferranti alternator, to make it work as a motor, is to put a big flywheel to it. There is another method available. Suppose we take two of these alternators, and connect them together on the same shaft, and make them act as a generator for two separate currents going along separate wires; and suppose that for our motor we use two similar alternators, also coupled on a common shaft, each alternator in each pair being electrically separate, so that the one gives or receives its maximum current when the other is giving or receiving its minimum current. One of the generators is feeding one of the motors, and the other generator is feeding the other motor, and the two generators are on one shaft, and the two motors on one shaft. Each of these pairs has got some dead centres. One generator and motor on one circuit have a moment when the motor is at a dead centre; but at that moment the motor of the other pair is not at a dead centre, but is at full work, so that at the moment when one motor, having no momentum, would naturally stop, the other one is driving it on. But it, in its turn, when it comes to a dead centre, is driven on by the first one, which is then in full swing. This is exactly analogous to the method adopted in the ordinary locomotive for getting over the difficulty of dead centres. There we have two cylinders working the driving wheels. One alone would be sure to stop at a dead centre sometimes, and stick and refuse to start the engine; but, by having two cylinders so arranged that the one is giving its maximum thrust at the time the other is giving no thrust, they are always, when they are at rest, in a position to start the engine. That is exactly analogous to the method I have suggested in connection with the Ferranti alternator. That arrangement which I have just now described is really a way of arriving at the rotating-phase motors which have created such interest in the course of the last year. This is not the exact arrangement which has been used generally in the rotating phase motors, but it is one which had been used by some makers and which works successfully. In the great electrical exhibition which was held at Frankfort last year there were a number of motors shown by different constructors, notably some by Mr Schückert, in which a continuous-current dynamo was used, but from the wires of the armature of this continuous-current machine wires were led, not to a commutator, but to rings fixed on the shaft of the motor. Four wires equidistant round the armature were taken to four rings, and from these he was able to take off two alternating currents going along two separate circuits to a distance, to another machine similarly fitted up. Each machine, you understand, possessed a commutator because it was a continuous-current machine; and it also possessed these four rings from which the current could be collected in the form of alternating currents. One of these machines being used as a motor and the other as a generator, we had all the advantages that I have just been speaking of. We had exactly the same effect as if we had had two Ferranti dynamos joined mechanically together on the same shaft and shifted through a distance corresponding to a quarter of a period. These machines worked extremely well. They were able to start, too, though not at full load. The method of starting them was not to excite the motor in the first place, but to leave the motor not excited. The current which was created in the armature induced currents in the field magnets, which tended to assist in starting, and very soon synchronism was obtained. As soon as the motor was going at its full speed the brushes were switched on to the commutator, thereby magnetising the field magnets, and the motor then ran as an alternating-current motor exciting its own field magnets.

At the time that the question of utilising Niagara was very prominently before the world, I had to give my opinion as to what was the best method of transmitting the power. That was in the year 1890. I stated then that, simply adopting machinery which we had thoroughly tested, and which we knew would not fail us, the best method we could possibly adopt was that of using alternating currents, and that the best way of using alternating currents was to use synchronising motors, such as the Mordey machine. I specially mentioned the Mordey machine because I had found it work so extremely well under all circumstances. I confess that I had had, perhaps, some special advantages which enabled me to see that this was really so satisfactory a machine for transmitting power over this distance. I had not only had special opportunities of testing very thoroughly the Mordey machine, and the Siemens machine, and the Ferranti machine, but I had also an opportunity of testing the Tesla machines, which were made at Pittsburg; and I felt at that time that the Mordey machine was the one which was most suitable for the purpose. Our object at that time was simply to transmit power. The distribution of the power through the town was of secondary importance. But even then I proposed to distribute the power through the town to large factories, which require to have their machines running all day simply by the alternating current, transformed down from 10 000 volts to 2,000 volts, because you cannot safely carry—or, at all events then, I could not recommend that you could safely carry—10,000 volts through the streets underneath the ground. You would have it then of 2,000 volts going to the large factories. For smaller shops and places, the proposition was to convert our high-tension alternating current into continuous current outside the town, and then carry it into the town for use with small continuous-current motors. That was the solution at that date.

Seeing that the rotating-phase motors have been such an enormous success, you may ask me why it was that I did not then consider that the rotating-phase motors were the best. I am not sure that they would be the best even with the experience which has come since; but at the time I felt that since no motors had been at work on this principle of larger size than a very few horse-power, it would be a rash experiment to go immediately up to machines the smallest of which would be 1,000 h.p. or 2,500 h.p.; and although there was every promise in the Tesla machine, and although I proposed that we should arrange things so as to be able to introduce the Tesla machine as soon as it was made on a larger scale, I did not think that the ordinary transmission over the distance from Niagara to Buffalo ought to be done by means of this machine. And at the present moment I still think that the synchronising motor is the best possible for that purpose. But with the enormous stride that has been made by the genius of Mr. C. E. L. Brown, of Switzerland, in the design of those machines that were shown at Frankfort, there is every reason to believe that we shall have a much greater efficiency.

Let me explain the principle, very briefly, of these rotating phase motors. Here is a diagrammatic illustration—a section of one of these machines, Fig. 2—in which we have four poles opposing each other, and an armature in the middle. The armature is supposed here simply to be wound like a drum armature, and to be short-circuited either at both ends or at the commutator end. In fact, the armature, for all practical purposes, may be supposed to be simply the ordinary drum armature of a Siemens's machine, with the commutator wound round with a bare copper wire, so as to be short circuited at that end. The armature conductors are closed upon themselves, and have no current coming in from the outside. There are two currents coming to the motor from the generating station in different phases. One current circulates round the two horizontal magnets, their polarity, at any moment, being of opposite kind. The other current circulates round the two vertical magnets. The one current is at the maximum when the other current is at the minimum, and one current is always just a quarter of a phase in front of the other current. The consequence of this is, that the magnetism which is induced in the armature will at one moment have a horizontal direction; a little later it will have a vertical direction; a quarter of a period later again, it will again have a horizontal direction, but opposite to what it was before—that is to say, the polarity will be reversed, and so on. It will be seen that, as the magnetism of any pole continually changes

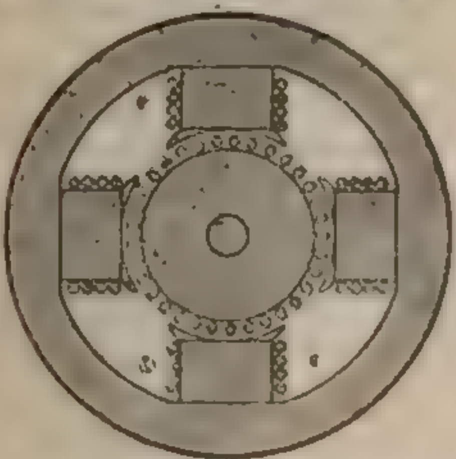


Fig. 2.

gradually from zero to a positive maximum, again through zero to a negative maximum, every complete period, and that the successive poles round the machine differ from each other's condition by an amount corresponding to a quarter of a period; there will be what is equivalent to a continual rotation of the whole magnetic field round the axis of the machine.

(To be continued.)

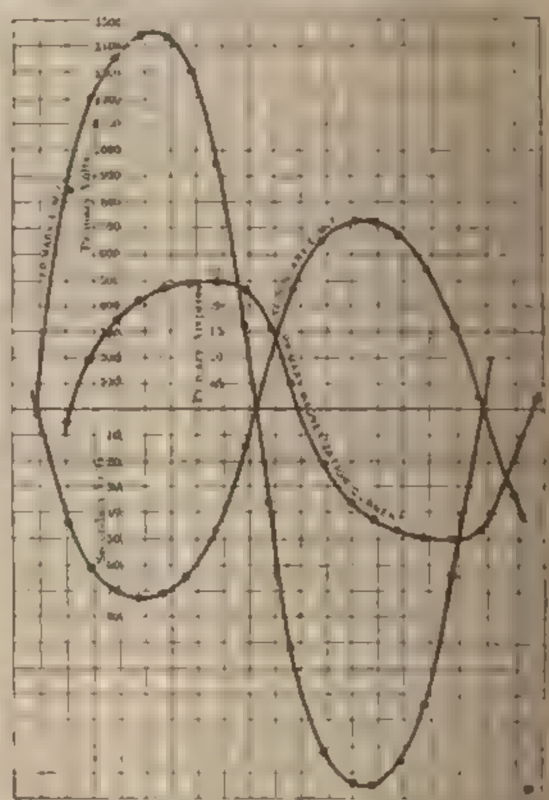
TEST OF A 17,500-WATT STANLEY TRANSFORMER.*

BY HARRIS J. RYAN.

The method employed for testing your 17,500-watt 1,000 × 50 volt transformer for a frequency of 132 periods per second, was as follows:

The power dissipated through hysteresis, eddy currents, etc., was determined by the use of a contact-maker, condenser, and electrometer, as described in the paper on transformers in the *Proceedings* of the American Institute of Electrical Engineers, vol. vii., p. 1. The transformer received current from a Westinghouse alternator at 132 periods per second. This machine was driven by a high-speed 60 h.p. tandem compound automatic engine, that had a fair speed regulation. It was found at the start, however, that the total loss of power in the transformer at full load was in the neighbourhood of but 3 per cent. of the load. On account of the natural drift of the speed of the engine within certain limits, it was not found practicable to measure the total power delivered to the transformer and that given out by it with such a degree of accuracy that the probable error would be less than 1 per cent. This would mean a probable error in the determination of the total power dissipated by the transformer of 33 per cent.

Were there no magnetic leakage in transformers, we would get a measure of the power lost through heating of the primary and secondary conductors by the product of the drop in volts observed on the secondary into the current output of the same. This measure would then be rigidly accurate when the secondary is at work on incandescent lamps and the primary magnetising current is as small as it is for this transformer. Actually, however, there is always some magnetic leakage that increases with the output of each transformer, and lowers the E.M.F. of the secondary by lessening the magnetisation through the same. Since this action results in no waste of power, in ignoring its presence, we shall make an error that counts against the transformer. It is highly probable that in a transformer with a drop in pressure due to load of only 2 per cent. or 2½ per cent., the error thus made against the efficiency at full load will not amount to more than 1½ per cent.



Curves Accompanying a Test of a Stanley 17,500-watt Transformer.

Primary, 1,000 volts; secondary, 50 volts; frequency, 132 P.P.S.; secondary on open circuit; primary effective E.M.F., 1,110 volts; secondary effective E.M.F., 56·0 volts; effective magnetising current, 105 ampere; power lost through hysteresis and eddies, 186 watts. Regulation: Drop in pressure from no load to full load, 2·3 per cent.; efficiency at full load, 96·9 per cent.; at half load, 97·1 per cent.; at quarter load, 96·0 per cent.; at one eighth load, 93·0 per cent.

The drop of secondary pressure due to load was observed by taking simultaneous readings of the effective pressure at the terminals of the primary and secondary when the transformer was loaded with lamps to an output of 17,500 watts, and when it was unloaded. In this way errors due to the drift of the speed of the engine are eliminated.

The accompanying diagram with its curves gives graphically the observations made for determining the power taken up by the transformer with the secondary on open circuit. From the curves of primary impressed E.M.F. and primary current the power lost through hysteresis and eddies in the iron core was determined to be 186 watts, with the pressure at the primary terminals of 1,110 volts. It is desirable to know the power lost at the standard pressure of 1,000 volts. In making this deduction we have assumed that this loss varies as the 1·7 power of the magnetic density in the iron core. The power lost in

* Report made by the Cornell University to the Stanley Electric Manufacturing Company.

the transformer on open circuit at a primary pressure of 1,000 volts is therefore 157 watts.

The drop in the secondary pressure due to load was determined from the following effective primary and secondary pressure readings which are given as the mean of a number of observations.

Full load.		No load.	
Primary.	Secondary.	Primary.	Secondary.
1,077	53·50	1,122	57·03

Reduced to a primary pressure of 1,000 volts:

Full load.		No load.	
Primary.	Secondary.	Primary.	Secondary.
1,000	49·67	1,000	50·83

Drop . . . . . . 1·16 volts, or 2·32 per cent.
Power lost in heating the conductors ... . $1·16 \times 350 = 406$ watts.

The variation of the efficiency with the load is given by the following equation:

$$\text{Efficiency} = 100 \frac{W}{W + H + K W^2}$$

Where W = the output of the transformer in watts;
H = the power lost through hysteresis and eddies in the core,
K depends upon the effective resistance.

Substituting the numerical values of H and K we have:

$$\text{Efficiency} = 100 \frac{W}{W + 157 + \cdot00000132 W^2}$$

The efficiencies at full load, half load, quarter load, and one-eighth load are 96·9 per cent., 97·1 per cent., 96·0 per cent., and 93·0 per cent. respectively. For one 16-c.p. lamp the efficiency is about 24 per cent.

For a determination of the all-day efficiency when the primary pressure is kept up at all hours of the day, it is assumed that this transformer would have a working output equivalent to 17,500 watts for five hours out of every 24. Under these conditions the all-day efficiency is 93·8 per cent.

THE PROBLEMS OF COMMERCIAL ELECTROLYSIS.*

BY J. SWINBURNE, MEMBER.

(*Concluded from page 360.*)

Passing electricity through the vats without agitation has also been tried, but it, again, is of little or no use by itself.

If, however, the skins are agitated and electricity is passed through the bath at the same time, the agitation circulates the liquid into the interstices, and the electric current sends the tannin through the walls of the cells, so that the leather is made infinitely faster than by the ordinary methods. Dr Rideal and Mr Trotter have made numerous and elaborate experiments on electrical tanning. The results of their work are given in the exhaustive paper read before the Society of Chemical Industry. I brought forward this as being probably the explanation during the discussion on their paper, and it agrees entirely with the results they obtained. The best results, according to this theory, would be secured by agitating the hides first to get the liquor into all the interstices uniformly, and then electrolysing to get the tannin into the skin itself; then agitating to refresh the solution in the pores, and then electrolysing, and so on. Messrs. Rideal and Trotter showed that this method does, in practice, give the best results. Leather made in this way also has a better chance of being uniform, because the outside is not acted on perceptibly quicker than the inside.

Tanning by agitation and electrolysis combined seems to have been invented by Messrs. Worms and Balé, and their process has been worked successfully for some time past in France, and in England by the British Tanning Company. Mr. Groth has developed a modification, and is also making leather by this process. Groth's appears rather better than ordinary leather, being more uniform in texture and giving better results when tested for tensile strength. It is shown at the Crystal Palace exhibition this year.

Ozone.

Now that induction coils in the shape of transformers have become commercial, there is every reason to expect that ozone will be made industrially. Mr. Fahrig has already been making ozone commercially in this country. He employs an alternate current which works a transformer which gives a high E.M.F. Air is first drawn through an apparatus which is supposed to separate the nitrogen by diffusion. As nitrogen and oxygen have nearly the same densities, it is hardly likely that much nitrogen is separated. The air is then led through the ozonisers. These consist of piles of corrugated metal plates with sheets of celluloid between them. They are alternatively positive and negative, being connected to the high-pressure side of the transformer. There is thus an alternating discharge from the corrugated electrodes to the celluloid sheets, so that the air is ozonised on passing through.

Messrs. Siemens and Halske employ ozonisers of the more usual form. Two concentric glass tubes are used. One electrode is inside the inner, and the other is outside the outer tube. High-pressure transformers are of course employed, and the air, or oxygen, is partly converted into ozone on its way there. Very little is known about the electrolysis of gases, if such an expression is admissible. The so-called silent discharge seems to work best, but the whole subjects now demands quantitative investigation. The use of glass must involve low efficiency, as glass possesses the property of dielectric hysteresis in a high degree. We also want to know the current density and frequency which give the best results. The arc, and, in fact, many forms of electric discharge, produce traces of nitrogen compounds. It is worth pointing out that if under any commercial conditions nitrogen compounds can be produced from air, there would be an unlimited demand. A works situated on a waterfall would have its power and material provided, and the only cost of production would be the interest on plant, and the wages of a man or two to look after the dynamos.

It has been said that chlorine acted on by the electric discharge is affected in the same way as oxygen. In the first place, chlorine is already quite a strong enough oxidant, and in the second, it is difficult to see how chlorine can form an allotropic modification.

Miscellaneous Processes.

Under this head I have classed a few electrolytic processes whose theory is obscure, and about whose practical success there may be some doubt.

Mr Webster has brought out an electrolytic sewage process. The effluent has electricity passed through it, and this is said to separate the solid material completely, and to kill all germs. Of course, when any sewage containing salt is electrolysed, it produces chlorine or hypochlorites, and these would act on organic matter. Hermite, for instance, has applied his process to the disinfection of ships. This does not seem to be the basis of Webster's process, however, and there seems uncertainty as to what the action is supposed to be, and why the solid particles should be influenced by the current.

The next process is ageing wine and spirits by means of the electric current. Whether there is really anything in this I do not know. Various inventors have brought out methods of ageing liquors by electrolysis. There is uncertainty as to whether the result is produced, and as to how it is produced. Various deleterious alcohols might be oxidised into others, but it is strange that electricity should select just those that give a taste which is unpleasant to the human palate. Mr. Turell uses a direct, while M. de Meritens employs an alternating current.

The sterilisation of milk by electrolysis is another process which is somewhat obscure.

The Electric Furnace.

The idea of using the heat of the arc for producing high temperatures for such purposes as melting iridium is about half a century old. Recently, however, we have had the Cowles furnace, used especially for the reduction of alumina. Properly speaking, this does not come within the scope of this paper, as there is no reason to suppose that electrolysis has anything to do with the reduction of the oxide. By pouring the power from a large dynamo into a carbon resistance, closed in so that the heat cannot readily escape, a very high temperature is produced. Alumina is then reduced by the hot carbon. It may be taken that at lower temperatures such as those produced by ordinary furnaces the affinity of aluminium for oxygen is greater than that of carbon, and that at the higher temperature the reverse is the case. It is not impossible, however, that the carbon in an ordinary furnace is inactive merely because it cannot get into good contact with solid alumina, and that in the Cowles furnace the alumina melts. In any case, there is no reason to suppose there is any electrolytic action going on.

The Cowles furnace is applicable to all processes which demand very high temperatures, such as the reduction of oxides of aluminium, magnesium, calcium, barium, strontium, silicon, chromium, boron, tungsten, and manganese. Of course many of these metals are not at present in demand; but then, it must be remembered, that may be because there has, until now, been no way of making them reasonably cheap. Many, if not all, of these metals have been already obtained by the Cowles process.

It is a question of economy whether the Cowles furnace should not be employed in many other reduction processes which do not require such high temperatures. The furnace is efficient, as the heat is applied where it is wanted, and little is wasted by radiation or convection. We thus have to compare

* Paper read before the Institution of Electrical Engineers.

an ordinary furnace in which the heat is applied badly, and a great deal is wasted because the gases go off at a very high temperature, with a system which begins with an efficient furnace working a very inefficient heat engine and an efficient electrical machine. The electrical furnace will doubtless soon be applied in many cases, especially those which ordinarily involve inefficient furnaces, and retorts which break down quickly or leak.

The manufacture of phosphorus is a good example. On paper the process is simple. Bone ash, or tricalcic phosphate, is not reduced by carbon at ordinary furnace temperatures, so it is treated with sulphuric acid, and converted into monocalcic, or superphosphate. Making this involves making sulphuric acid, or buying it. Acid phosphate is then heated in retorts with carbon, and two-thirds of the phosphorus is obtainable theoretically. If sand is used it acts as a strong acid, or, rather, anhydride, at high temperatures, and all the phosphorus should be obtainable. The retorts, of course, give rise to trouble and expense. Messrs. Readman, Parker, and Robinson, by employing the electric furnace, can deal with mineral phosphates, and require no sulphuric acid. I do not know whether carbon, at the temperature attained in the electric furnace will reduce calcium phosphate to calcium and phosphorus, or whether calcium phosphide is formed. With sand, of course, calcium silicate is formed. One might expect that this would be reduced to calcium and silicon, in which case it would be reasonable to suppose that the operation could be carried on without silica. It has been said that some oxides which can be reduced by very hot carbon when dealt with separately, can form compounds that cannot be reduced if one oxide is strongly acid in comparison with the other. If that is the case, though the lime and silica might be reducible separately, the combination of the two, calcium silicate, might be irreducible. Whether calcium silicate is reducible or not, silica must of course be employed if the phosphate would otherwise be converted into phosphide.

It would be well to see what other reduction processes could be dealt with economically by the Cowles furnace. Doubtless there are many, and Messrs. Parker and Robinson are sure to explore the field pretty thoroughly.

CONCLUSION.

A very few of the possible applications of electrolysis have been described in the foregoing paper, and the labours of many workers have been passed without mention. This was unavoidable. There is also another difficulty in writing such a paper as this. I have not worked at all the processes myself, and have had to rely on published accounts in many cases. Out of every hundred new inventions in electro-metallurgy, ninety are impossible chemically or electrically. If I have ruthlessly cut out a possible or admitted an impossible process, I must ask pardon on account of the impossibility of trying all the processes myself, even experimentally, and must plead that I have been as sceptical as possible.

There are other directions in which electrolysis may play an important part. The improvement of the manufacture of white lead deserves the most careful attention. The Dutch process is unhealthy, costly, and barbarous. The electrolytic manufacture of aniline dyes has received considerable attention. Dr. Goppelsroeder has done a good deal of work in this direction, and samples of silks dyed by electrolytically prepared colours were shown both in the Paris and the Frankfort electrical exhibitions. The extraction of gold from sea water, which is said to contain minute quantities, need hardly be treated seriously. Even if it were possible, such a process would be of no use. All improved processes for obtaining precious metals merely enrich some at the expense of others, and reduce the value of the metals. Obtaining gold more easily would be no good to the community unless it became cheap enough to be used commercially.

NEW COMPANIES REGISTERED.

Akester Electric Syndicate, Limited. Registered by H. H. Price, 9, John-street, Adelphi, W.C., with a capital of £15,000 in £50 shares. Object: to carry into effect an agreement made between W. H. Akester of the one part and P. R. Low, on behalf of this Company, of the other part, for the acquisition of certain patents relating to improvements in electric arc lamps, and to develop and turn to account the same, and as electrical engineers generally. There shall not be less than three nor more than six directors; the first are the first two signatories to the memorandum of association and one other, not named. Qualification, £50. Remuneration, £60 per annum, not divisible.

Carbon Battery Company, Limited. Registered by H. C. Bull, 29, St. George's-road, S.W., with a capital of £10,000 in £1 shares. Object: to carry on business as producers and suppliers of electricity in all its branches; as dealers in magnesium, aluminium, etc.; to acquire certain patents and inventions relating thereto, and to develop and work the same. Registered without special articles of association.

COMPANIES' MEETINGS.

CROMPTON AND CO., LIMITED.

An extraordinary general meeting of the shareholders in Crompton and Co., Limited, was held last Thursday at the [illegible] Mansion House buildings, Mr. R. E. Crompton presiding, to consider a resolution for increasing the capital to £[illegible] by the issue of 22,000 additional ordinary shares of £5 each, to rank as regards dividends and in all other respects pari passu with the existing ordinary shares.

The Chairman (Mr. R. E. Crompton), in proposing the resolution, stated that the additional capital was required in consequence of the growth of the Company's business. He pointed out that the firm of Crompton and Co. originally consisted of Mr. Albright and himself, and that they still held the whole of the ordinary shares. At first sight it seemed that the new issue might be prejudicial to the ordinary shareholders, but after careful consideration they had come to the opposite conclusion. During the last few months they had undertaken very important contracts, and there were others in such an advanced state that they were sanguine that they would be able to keep their works fully employed, and he saw no reason to doubt a continuation of the increase in the Company's business, such as they had experienced in the past. Reference in much the same terms as reported in our last issue was made to the successfully completed electric lighting of the city of Pretoria, South Africa.

Mr. A. F. Albright seconded the motion, which was carried.

BUSINESS NOTES.

Dundee. The tender for switchboards for Dundee must be sent in by Saturday, the 22nd inst.

Burnley. Next Wednesday is the last day for receiving the tenders for the Burnley electric plant.

Toxteth Park. –The Toxteth Local Board have been discussing the details as to the proposed electric lighting of the district.

York. Tenders for lighting plant for York are required by Nov. 21. Particulars of the town clerk, York; fee, two guineas.

Blackpool Telephones. Serious complaints have been made as to the working of the telephone service to the Blackpool [illegible] station.

Lamp Columns. Messrs. Jukes, Coulson, Stokes, and Co. have recently received a large order for lamp columns at £5 [illegible] per ton.

Western and Brazilian Telegraph Company. The receipts for the past week, after deducting 17 per cent. payable to the London Platino Brazilian Company, were £3,851.

Direct United States Cable. – The Directors have declared an interim dividend at the rate of 3½ per cent. per annum for the quarter ended September 30, payable on the 24th inst.

Waterford. The streets of this city are once more lighted by gas and an end is thus made, at least for the present, to the plucky attempt to oust gas in favour of electric light for the street lighting.

Hornsey. The Hornsey Local Board has declined to allow the County of London Electric Lighting Company to carry out electric lighting in the parish, being of opinion that it would not be successful.

Central Stations. Besides the central station for Coatbridge (9,000 lamps capacity), Messrs. J. E. H. Gordon and Co., Limited, have secured the contract for the supply of central station plant for Windsor.

Elihu Thomson Patents. –Mr. Elihu Thomson is desirous of selling or exploiting the French patents for dynamos, regulators and meters. His agent is M. Emile Barrault, 58 bis, Chaussée D'Antin, Paris.

The Tramways Institute. This institute has removed from [illegible] Coleman-street to large and convenient premises at Broad-street Station Buildings, 18, Eldon-street, E.C., with entrance also at 19, Finsbury-circus.

Molesey. At the last meeting of the Local Board [illegible] proposals, the terms of which have not yet been made public, on the subject of electric lighting, was referred to the General Purposes Committee.

Bath. A meeting of the Bath Sanitary Authority has been summoned for 25th inst., amongst other things, to receive and consider a report from the Electric Lighting Committee adopted by the Surveying Committee.

Manchester. The increase in the necessity for lighting facilities is so great that it is proposed to spend £[illegible] in extensions of the gas works. The electric light station, when it gets going, should have plenty of scope for developing demand.

Road Breaking. The Bournemouth Electric Light Company have written to the Town Council to ask them to make a reduction in the charge for repairing roads broken for the laying of cables, but the Council are not prepared to make a reduction.

City of London Electric Lighting Company.—Letters of allotment and regret in respect of the issue of £200,000 6 per cent. cumulative preference shares were posted on October 6.

Electric Bells at Church.—A set of electric bells to ring in all parts of the house has been fitted to Spurgeon's Tabernacle. All strangers are kept standing, and five minutes before service the signal is given, followed by a rush to the best seats.

Watford.—The Watford Board of Guardians had before them the terms of the Watford Exchange Telephone Company for placing the workhouse on the exchange, but the Guardians did not think the additional convenience would warrant the expense.

Electric Calls for Poole.—At the special meeting of the Poole Town Council last week the Fire Engine Committee recommended, and it was agreed to, that the borough surveyor should prepare specifications as to the repair and maintenance of the electric call apparatus.

City and South London Railway Company.—The receipts for the week ending October 9 were £859, against £747 for the same period last year, or an increase of £112. The total receipts for 1892 show an increase of £995 over those for the corresponding period of 1891.

Dover.—Alderman Adcock, at the last meeting of the Dover Town Council, said he thought the Council's provisional order would expire before the agreement with the Brush Company was completed. The Mayor said he believed that there had been real cause for the delay, but perhaps it would be best to waken them up.

Electric Fire Alarms for Liverpool.—The Liverpool Watch Committee, at the weekly meeting on Monday, decided to recommend the City Council to adopt, at the monthly meeting tomorrow, the principle of electric fire alarms for the city, a system which has worked efficiently in London, Glasgow, and other large centres.

Taunton.—The following figures are given by Mr. William Porter, in answer to request, with reference to the loss at Taunton electric works during 1891. Working expenses, £1,867; income from rent, £1,251; loss on year's working, £376. The figures have been already published, he says, in the report of the Joint Committee.

India.—The *Indian Engineer* is intending to issue a thin paper copy of their paper at a cheaper rate including postage. Subscribers have the advantage of being able to obtain free of charge any special information they may require from the Calcutta or London offices. The address of the latter is 1 and 2, Victoria-mansions, S.W.

Aberdeen.—The Gas Committee reported that the total area of the ground purchased by the Council for the building for gas and electric lighting was 1,624½ square yards, of which they proposed to allocate 581½ square yards for gas purposes, and 1,043 square yards for electric lighting purposes, the total feu-duty being £10. 4s. 2d. The report was adopted.

Leeds Tramways.—Some time must yet elapse before the negotiations for purchase by the Leeds Corporation of the tramways can be settled, awaiting the decision of the High Courts on the price to be paid. As it is known the authorities look well on electric traction, their purchase, when it occurs, may influence the adoption of this method for these lines.

Martiny, Limited.—A company has been formed with the formidable title of "Société Française de Caoutchouc, Amiantes et Câble (Martiny, Limited)." This combination comprises three companies, whose names appear in the compound title. The capital is five million francs, and the London office is 37, Lombard-street, with works and showrooms in France.

Circus Lighting.—A speciality has lately been made by Messrs. Blakey, Emmott, and Co., the well-known electrical engineers in Halifax, of circus lighting. One circus having been fitted with engine and dynamo for arcs and incandescents, the rest have followed suit, and quite a number of "Original Wombwells" have been fitted up, with much satisfaction to the proprietors and the public.

Wigan.—The inhabitants of Wigan have not taken up the Gas Committee's electric lighting scheme very enthusiastically, the chairman reporting last week that only eight or nine had as yet filled in the circular affirmatively. The committee do not see their way to spend £30,000 in a central station with such small encouragement. Perhaps private endeavours would result in a better result.

Burton.—At the monthly meeting of the Burton Town Council, Alderman Lowe, in moving the adoption of the Gas and Electric Committee's report, said that the Board of Trade had approved the scheme for lighting a portion of the town by electricity, and the manager had received instructions to prepare the necessary plans. The committee would now push on the work as fast as possible. The motion was agreed to.

Sutton (Surrey).—Tenders are invited for lighting (at per lamp) for lamps of one burner and for lamps of two or more burners for the public lighting of their district, by gas or other illuminant, for one year from Nov. 1 up to Nov. 1, 1893, for the Sutton Local Board. Tenders should be sent to Mr. Thos. D. Pettiver, clerk, Sutton, marked outside "Tender for Public Lighting," by 12 noon on 19th inst.

Chiswick.—The Board of Trade have written to the Chiswick Local Board with reference to the contract for the supply of electric light, stating that the Board would lose no time in considering the draft agreement with respect to this matter which had been submitted by the local authority. Some delay would, however, arise through the absence of their counsel in Scotland. The clerk was instructed to write protesting against the delay.

Metal Cutters.—The bandsaw machines of Messrs. Greenwood and Batley, Leeds, are exceedingly useful for the quick trimming of metal forgings for dynamos and engines. Instead of laboriously boring or planing out a crankshaft or other large slot, the new method consists of drilling a hole, running round a metal band-saw, and in a wonderfully short time a solid lump is cut out, and there only remains to trim up the edges in the planing machine.

Vaudeville Theatre.—Messrs. Mather and Platt, Limited, of 16, Victoria-street, have carried out the lighting of the Vaudeville Theatre, the number of lights in the building being 260 lamps of 16 c.p. in the stage, 130 lights in the auditorium and dressing-rooms, and 10 100 c.p. lamps in the central dome light. The whole of the contract, including the supply of fittings, resistances for stage lights, etc., has been completed in the short time of 12 days.

Hammersmith.—A lively discussion took place at the Hammersmith Vestry meeting last week on the subject of electric lighting. The Electric Lighting Committee reported that having carefully considered the area throughout which the Vestry is to lay the distributing mains within a period of two years, recommended that the Vestry should schedule certain streets. The localities named were the cause of the discussion, and in the end two other roads were added to the list.

Rangoon.—At a Municipal Sub-Committee meeting held at Rangoon, India, on the 13th September, an offer was read from the Edison-Swan Company to light up the town for the same price as now paid for oil lighting. The same number of electric lamps as there are now oil lamps would be used with three times the illuminating power. A concession of 30 years is asked, with a guarantee of 5 per cent. of the net profits to the town. The engineer is to report upon the project.

Blackburn.—At the monthly meeting of the Blackburn Town Council, Alderman Eastwood said he noticed there was a resolution for the purchase of a plot of land in Jubilee-street as a site for an electric light generating station. Whilst he had no objection to offer, he should like the chairman of the Gas Committee to promise that no chimney should be erected on that site. He thought the difficulty could be met by erecting the chimney in the gas company's yard on the other side of the street.

Companies of the Month.—The following electrical companies were registered during the past month:

Carbon Battery Company, Limited, £1 shares	£10,000
Electro Alkali Company, Limited, £10 shares	160,000
London Health Electrical Institute, Limited, £1 shares	10,000
New Electro Metallurgical Syndicate, Limited, £1 shares	10,000
New Electricity Supply Company of Croydon, Limited, £5 shares	40,000

Derby.—The Electric Lighting Committee of the Derby Corporation have resolved to recommend to the Council the acceptance of the following tenders in connection with the scheme for the supply of electric light in the borough, recently sanctioned by the Council: For the buildings, Messrs. Walkerdine and Co., £3,870. 4s. 3d., and for the engines and dynamos Messrs. Siemens Bros., London, £10,781. The engineers are Sir Frederick Bramwell and Mr. Harris, and their estimates were for the buildings £5,606, and for the engines, etc., £10,500.

Mill Lighting.—There is a large corn mill situate in the Waterloo Bridge-road, known as Seth Taylor's, which is a striking building, one peculiarly fitted, it would seem, to be lighted by electric light. Some four or five years ago it was burnt down, if we remember rightly, and since then it has been the stock target for electrical estimates. Many good firms have made overtures, but it has fallen to the lot of Messrs. Easton and Anderson at last to secure the contract. A large notice is now affixed, stating that a complete plant is being put in by the Erith firm.

Kelvinside.—A correspondent says that instead of the Kelvinside Company having chosen an ornamental design of chimney-shaft fitting to the position, it seems that they had deliberately chosen the most ugly and offensive pattern—coarse and square. The chimney question is indeed, a raging one, it would seem, for this correspondent says it will have the effect of preventing him taking the electric light. The secretary has written to say that the best advice has been taken, and that the directors, recognising the weight of the objection, have given orders that 40ft. shall be taken off the height, the saving in cost to be applied to making the shaft more ornamental.

City Commission of Sewers.—A meeting of the City Commission of Sewers was held on Tuesday at the Guildhall, Mr. Alderman Treloar presiding. A report was brought up by the Streets Committee relative to accounts from the City of London Electric Lighting Company, amounting to £1,211. 5s. 7d., for lighting certain of the public ways of the City up to Midsummer Day, and recommending that the accounts should be paid, without prejudice to the contracts and provisional orders. This was agreed to. An application by the City of London Electric Lighting Company for permission to use some of their pipes for telephonic purposes was referred to the Streets Committee for consideration and report.

Shoreditch.—The annual report of the Shoreditch Vestry, which is just issued, mentions as one of the most important items the acquisition of the monopoly of the electric lighting of the

[illegible] lighting and [illegible] experimental stage to that of [illegible] regarded as the luxury of the rich, [illegible] a necessity for the poor owing [illegible] advantages which electric light possesses over [illegible] of illumination."

Canterbury. – The Electric Light Committee of the Canterbury Town Council reported at their meeting last week that a letter had been received from Messrs. Mewill asking that various alterations should be made in the deed of agreement and the deed of transfer. The committee were unable to agree to certain of the suggested alterations and the town clerk had been directed to inform Messrs. Mowil that the drafts as they now stand were approved by Mr. Moulton, Q.C., to whom they were sent at Messrs. Mowil's suggestion. The Mayor said he had only to state that they were for once unanimous in their report. No reply had yet been received from the Brush Company. The matter had not dropped. The minutes were confirmed.

Middlesbrough. The sub-committee's attitude on the electric lighting question is that a provisional order ought to be obtained which would enable the Corporation to maintain the ground for two or three years during which time they could either carry out the work or pass their powers to a private company. The suggestion by Mr. Forbes that it would be better to allow a company to undertake the supply on conditions of repurchase after a certain number of years was not thought desirable. Mr. Taylor is of opinion that the Corporation should undertake the work at once, but the ownership by the town of the gas works, and the considerable revenue derived therefrom (which might suffer) is the real obstacle in the way of immediate adoption of a scheme.

Ravensthorpe. – At the meeting of the Ravensthorpe (Yorks.) Local Board Mr. J. H. Tattersfield read a resolution passed at the ratepayers' meeting urging upon the Local Board the desirability of promoting the introduction of the electric light on account of the heavy price paid for gas and that all efforts up to now towards obtaining a reduction had proved futile. He urged the introduction of the electric light, and was not in favour of buying the gas plant. Mr. Townend assured the deputation that the Board had not lost sight of lighting the township with electricity. The matter had been before the Board some 18 months. They had been to see an installation, and he might say the members had it in their minds to light Ravensthorpe with electricity, but as electric lighting in their minds was yet only a matter of experiment, and was likely to develop, they thought it wisest to wait.

Crompton and Co., Limited. Crompton and Co., Limited, announce the issue of 12,000 ordinary shares of £5 each, of which it is not proposed at present to call up more than £1 per share. The Company was formed in July, 1888, to acquire and carry on the business of electric light engineers, founded by R. E. Crompton and Co., of Chelmsford and London. The capital of the Company was £300,000 in 30,000 7 per cent. preference shares of £5 each, of which 25,916 have been subscribed for and allotted, and 30,000 ordinary shares of £5 each, of which 8,000 have been allotted as fully paid up. The business, since it was taken over by the Company, has very largely increased, and the object of the present issue of shares is to provide the further working capital required to continue the development of the business, and to facilitate the carrying out of certain large contracts which have recently been secured, and of others which are in negotiation.

Brazilian Submarine Telegraph Company. The report for the half-year ended June 30 states that the revenue amounted to £111,870, and the expenses to £29,557. After providing for debenture interest, sinking funds, and income tax, there remains a balance of £68,690, to this is added £19,883 brought forward, making £88,573. A quarterly interim dividend, amounting to £19,500, has been paid, and £40,000 transferred to the reserve fund, increasing that fund to £379,714. The Directors now recommend a final dividend of 3s. per share, making a total dividend of 6 per cent. for the year, and a bonus of 1s. per share, both tax free, which together will amount to £26,000, leaving a balance of £3,073 to be carried forward. The dividend and bonus will be payable on the 20th inst. On July 31 last £15,800 was transferred to pay off the 158 bonds of the 1884 issue drawn for redemption in April last. This reduces the debenture debt to £111,400.

Accrington. – At the Accrington Town Council meeting last week some detailed information as to the proposed electric lighting station came out in the discussion. The committee intended to use the land on which at present were Higham's baths, the area being 2,000 yards and the price 2s. a yard. The town clerk said they had not yet entered into an agreement with Mr. Higham, and the Mayor said the matter was not completed in any way. Councillor Sparke said their determination was simply to get specifications from Mr. Shoolbred, but they were not pledged to go on with the scheme. The Council have resolved that Mr. Shoolbred be instructed to prepare plans, estimates, and specifications for the construction on the above site of a central electric lighting station, with two engines of 40 h.p. each for a commencement, and the necessary station instruments and distributing plant, previous to application being made to the Local Government Board for their sanction to the borrowing of the necessary amount. This amount, the clerk stated, was rather under £10,000.

Cost of Electric Traction. – The following circular letter is being issued by the Electric Power Storage Company to the chief tramway companies in Great Britain, and is the best possible answer to the criticism that has lately been made on the expense for maintenance of batteries and electrical gear of tramcars: "Dear Sir, – We beg to call your attention to the fact that we are now prepared to negotiate for the working and maintenance of approved tram lines equipped with self-contained or storage electric cars. The terms under which such working and maintenance can be contracted for necessarily vary with local conditions, but the maximum charge would be 66 per cent. of the gross traffic receipts. You will readily note that such an undertaking should and does constitute the most effectual guarantee of perfection of service, and we shall be pleased to discuss the matter further with you at any time." We dealt with this offer in a recent leader, and trust this offer from a responsible company like the E.P.S. Company will have a practical and immediate response.

Barnet. The Finance Committee reported at the last meeting of the Barnet Local Board that the item for the [illegible] costs of a provisional order for electric lighting was eliminated. With regard to the clerk's bill in connection with the [illegible], it was resolved that Mr. Poole's agents be asked to return the original list of Mr. Moulton's fees, and also that the bill of costs be taxed in the Court of Queen's Bench, and that Mr. [illegible] appear on behalf of the Board. The clerk read the following letter from the secretary of the Local Government Board: "Sir, – I am directed by the Local Government Board to acknowledge the receipt of your letter of the 10th ultimo, relative to the application of the Barnet Local Board for sanction to borrow money to defray certain legal expenses incurred by them, and I am to point out that the loan of £500 for legal expenses was sanctioned in 1878 because those expenses were incurred in connection with the execution of permanent works. In the present instance the expenses were not so incurred, and under these circumstances no loan can be sanctioned by the Board in respect of them under the Public Health Act, 1875."

Bowness. – At the monthly meeting of the Bowness Local Board the clerk read a letter received from Mr. Fowkes regarding a proposal to introduce the electric light into the district, and stated that he had prepared the draft of an agreement between the Board and R. H. Fell and Sons, Limited, which had been submitted to the latter's solicitors in London who, to make it satisfactory to themselves, had put in two or three slight alterations. Having read the draft, Mr. Gatey stated that Mr. Fowkes had also made a communication respecting a proviso which enabled the Board, if they thought proper, to take over the electric lighting at a stipulated rate at the end of 14 years, which he considered too short a time, and suggested that it should not be less than 21 years. After some discussion, Mr. Holland proposed that "subject to the terms embodied in the draft agreement between the Bowness Local Board and R. H. Fell and Sons which then lay on the table, the Bowness Local Board approve of the same and recommend that the Main Roads Committee accede to the request made for permission to lay a main electric cable down beneath the main roads in the district." Mr. Westlake seconded the motion, and it was carried.

Portsmouth. At the Portsmouth Town Council meeting last week the Electric Lighting Committee submitted tenders for the erection of the building for the electric lighting station and recommended that the tender of Mr. T. W. Quick be accepted. The prices were: Mr. W. W. Evans, £10,270; Mr. T. P. Hall, £9,425; Mr. R. W. Learmouth, £8,367 5s. 7d.; Messrs. E. and A. Spriggings, £9,300; Mr. T. W. Quick, £8,400. The town clerk read two letters from Mr. W. W. Learmouth, one of the contractors, complaining of the unfair manner in which he had been treated by his tender – the lowest – being passed over through a slight informality. The amounts of the bonds, he owned, were not on the tender, but they could have been easily ascertained by referring to the bill of quantities attached. A second letter pointed out that in Mr. Quick's tender the sureties' names were not written by the sureties themselves, and he submitted that this was a more fatal informality than his. Alderman [illegible], chairman of the committee, pointed out that the names of the sureties appearing on Mr. Quick's tender were put in with authority. The reason the work was not started before, he said, was that the Local Government Board had been so tardy in sanctioning the borrowing of the money. Mr. Quick's tender was accepted.

Ardrossan Harbour. The installation of the electric light at Ardrossan Harbour has been completed. It consists of 17 arc lamps of 3,000 c.p. each, distributed around the harbour and in the coal elevators and Caledonian Railway Station. The dynamo and engine are fixed in the hydraulic engine house. The engine is specially adapted for electric lighting work, and is of the vertical high-speed type, with closed crank chamber, with a cylinder 9½in. diameter by 9in. stroke. The dynamo is a series-wound machine, giving an output of 15 amperes, at an electrical pressure of 1,000 volts, which is equivalent to supplying 20 lamps of 3,000 c.p. each, or a total of 60,000 c.p. The dynamo is mounted on adjusting rails, and is driven by one of Hendy's patent belts from the flywheel of the steam engine. The conductors to the various lamps are carried overhead, and the method adopted is an exceptionally secure one. In view of the comparatively high electric pressure, the conductors are highly insulated throughout with vulcanised india-rubber, and these conductors are suspended by leather thongs from steel suspending wires stretched between insulators from pole to pole, this arrangement giving perfect safety from accident through short circuit. The lamps are of the double carbon type, and are capable of burning for 16 hours without adjustment. Each lamp is provided with a double-pole cutting out switch. The lighting has been found a great boon to passenger steamers receiving and disembarking passengers, and in

facilitating the rapid loading and discharging cargoes during the night. The work has been carried out, as we stated last week, by Messrs. Mavor and Coulson, of Glasgow, under the superintendence of Messrs. Strain, Robertson, and Thomson, the Harbour Company's engineers.

Manchester.—At the monthly meeting of the Manchester City Council held last week questions were asked by Mr Batty and Mr Smallman, who wished to know, on behalf of ratepayers who had completed their installations, when the electric light would be available, but so far, Sir John Harwood said he was afraid his answer to the question must be in a somewhat stereotyped form namely, that there were difficulties in the way that the Gas Committee did not at first anticipate. One of the difficulties was the erection of a large chimney, the completion of which could not be hurried without risk to the stability of the structure. Another was that a large room was being lined with glazed bricks, and there was delay in the supply of material, because they were bound to have the bricks from one maker in order to have them all of the same colour and quality. He might add, also, that everything was being done that could be done, and there was no unnecessary delay. The mains were being laid in the streets in a very efficient manner, and the wires would be ready by the time of the completion of the other works. Possibly that would be soon after Christmas, he was inclined to think it would be in March or April. In addition to the matters he had mentioned there were conflicting interests between contractors which kept back the work at the electric light station, but no body of men could give more attention to the operations than was being given by the Gas Committee.

Blackpool. Mr Councillor Pearson, at the Blackpool Town Council meeting last week, in moving that the tender of Messrs. Hammond and Co should be accepted, said the amount of the tender originally was £18,978. The committee had, however, at some of their meetings considered it advisable to include certain extras for oil pumps, water gauges, and Hopkinson's valves, so that the total amount of the tender would be £19,119. 15s. There were deductions from this amount in accordance with an arrangement by the committee. For instance, the committee had resolved that they would be protected by having a well known type of boiler, and it was arranged that one of Messrs. Galloway's manufacture should be supplied to them, instead of a multitubular boiler as at first suggested. This reduced the tender to £18,709. 15s. This amount did not include the building nor the junction boxes, etc., all of which would have to be completed at the expense of the Corporation, but they anticipated that the total expense would come well within the amount which it was intended to borrow upon the sanction of the Board of Trade being obtained viz., £26,000. If they succeeded in carrying out their scheme for the amount of money named, the committee would consider that they had got exceedingly good value for their money and a satisfactory result of their labours. The station would be equal to generating current to light at one time 6,620 incandescent lamps of 8 c.p. each, besides lighting 110 arc lamps of 2,000 c.p. each for illuminating the Promenade. The gas department were prepared to manage the old part of the electric lighting until the committee had carried out their scheme, and they were, moreover, prepared to assist the new scheme to their fullest extent in the future. He added that arrangements had been made whereby the same dynamos would drive the tramways during the day and generate the current for the illumination of the town at night. The minutes were carried.

Whitehaven.—At the monthly meeting of the Whitehaven Town and Harbour Trustees the minutes of the Electric Lighting Committee were read. The minutes showed that on September 6 Dr. Hopkinson's opinion had been asked on the tenders of Messrs. Galloway, Limited, and the Lowca Engineering Company for boilers, and a second tender was invited from Messrs. Galloway for two Lancashire boilers of equal capacity to the two Galloway boilers specified by Dr Hopkinson. On September 14 the committee further considered tenders for the supply of boilers, and recommended that the tender of the Lowca Engineering Company for the supply of two Lancashire boilers be accepted, that the clerk write to Messrs. Ramsay Bros., and call their attention to the letter to them from the town surveyor of the 10th inst., and give them notice to desist from any interference with the powers granted to the trustees under the Whitehaven Electric Lighting Order, 1891. On 20th September, Dr Hopkinson attended the meeting. The solicitor was instructed to prepare draft agreements to be entered into between the trustees and the various contractors for the electric lighting plant and on 28th September the committee recommended that the offer of the Boiler Insurance and Steam Power Company, Limited, of the 27th inst., to inspect the two boilers during construction at the Lowca Engineering Works, be accepted. After reading these minutes, the chairman, Mr J. G. Dees, J.P., proposed as a specific resolution that the following tenders in connection with the proposed scheme for electric lighting be accepted, subject to the sanction of the Local Government Board being obtained for the loan applied for viz., The tender of Messrs. Ramsay Bros., Whitehaven, for iron and steel work for foundations of engines and dynamos in sewerage engine house, the tender of Messrs. Willans and Robinson, for four sets of Willans engines and Crompton dynamos, the tender of the International Okonite Company, Manchester, for conductors; and the tender of the Lowca Engineering Company for two Lancashire boilers. The motion was seconded by Mr Pattinson. The Chairman said there had been a pretty large competition. The tenders were invited from certain firms that were selected as the best possible firms to do the work that was required. Most of these things were specialties, and only made by certain firms; so that it was no advantage to advertise generally. The resolution was put and carried. The minutes of the Electric Lighting Committee were then put and carried. Mr Bowman objected to a further sum than the £14,000 being asked for as was intended, and said he would raise the question again at another meeting.

Accrington Co-operative Society. This society have had before them the report of their committee on the advisability of the introduction of electric light. The chairman of the society said they were aware that the Accrington Corporation had obtained power to supply the electric light, and the society had been asked if they would become customers if the Corporation laid down plant. The committee were given to understand the price from the Corporation would be from 6d. to 9d. per unit. At that price it was doubtful if any saving could be effected as compared with gas at 2s. 7½d. per 1,000ft., and the committee decided not to recommend the society to become consumers. They then determined to make a full enquiry, and a sub-committee of four, along with the manager, was appointed to visit places where the light was in use. The result was that they had decided to ask the members' permission to proceed with the work. They viewed the question from three standpoints (1) its advantage over gas as an illuminant, (2) from a sanitary point, and (3) its cost. For the first, it had a decided advantage over gas consumed in the ordinary way, for the second, there was hardly any comparison, the advantage being so much in favour of the electric light, in one case the top room of a large building was almost as cool as the bottom room, and the manager told them the electric light had saved them scores of pounds in depreciation, and with regard to the third, the society visited supplied them with full details of the cost. These showed that the light was produced at less cost than gas as estimated by the number of lamps in use against the number of gas burners. With such a favourable report the committee felt warranted in asking for estimates, and seven firms all more or less local had responded. There was considerable difference in the amounts, but the figures for laying the plant ready for work were about £1,200. The estimated depreciation on the buildings used was £10, and on plant at 10 per cent. £120, while on coal, oil, sundries renewals, and wages, about £137, or a total expenditure yearly of £267. The gas bill for 12 months at 2s. 7½d. was £272; at 3s. 0½d. it would be £315, and nothing was credited in those figures for lessened depreciation in stock, better light, nor gas fittings. The committee thought they would be justified in making the venture. The motion to do so was carried unanimously.

Londonderry. A special meeting of the Londonderry Corporation was held on Tuesday, the Mayor (Dr. MacCullagh, J.P.) presiding, to consider a report of the Lighting Committee in favour of proceeding with the introduction of electric lighting into the streets of the city. Councillor Magee, chairman of the Lighting Committee, moved the recommendation that the public lighting of the city by electricity under the provisional order of 1891 be proceeded with, and that a sum not exceeding £12,500, already voted by the Council on December 16, 1890, be applied towards establishing and completing the public installation. Councillor Magee reminded the Corporation that they had been first driven into action in the matter by the appearance of the House-to-House Company with a request that they should get powers which the Corporation thought should be retained in the hands of the citizens' representatives. The Corporation had got a provisional order, but, in case they failed to put it into force, the Board of Trade might transfer the powers which it gave them to any public company so applying. The passing away of these powers from the Corporation to a company would be disastrous, and leave the city at the mercy of such electric company and the gas company, who might combine to give the city a starved light. The new light could be introduced without any additional taxation. The scheme was to substitute electric lighting for gas throughout the city. The gas lamps cost the Corporation over £2,000 a year, and this sum alone would be more than sufficient to cover the initial cost of the proposed installation. Not only would that £2,000 cover interest on capital, but it would provide a sinking fund to pay off their loan in 35 years, in addition to leaving a margin of profit calculated at £200 a year. The arc lamps would have 2,000 c.p. The public lighting would be by arc lamps worked by continuous currents at high pressure placed on posts at an elevation of 25ft., and arranged on two separate circuits in each street, so that half the light could be extinguished at a time, and that failure was practically impossible. Where any street was too small for arc lamps, small incandescent lights would be substituted. They proposed to follow the system which had proved so successful in St. Pancras and Dublin. Councillor Turner seconded the motion for the adoption of the recommendation, and said the citizens were anxiously looking for the introduction of the electric light. Alderman M'Learn, J.P., approved generally of the scheme, but was disposed to move as an amendment that the question of the eminent engineer to whom the plans would be submitted should be left open to the Council in committee to discuss. The report bound them to Dr. John Hopkinson. He also thought they should not be bound to accept the particular site recommended by the committee for the generating station. Councillor Pollock, J.P., asked was it necessary the site should be near the quay. Mr Blake, the electrical engineer under whom the Corporation have proceeded, was in attendance. He replied it was certainly necessary. If they had not the benefit of the river water for condensing purposes there would be such a large quantity required that the water supply would be interfered with. Several members urged some delay, with the object of getting the latest advice.

Eventually the report was amended in the direction urged by Alderman McLaren and unanimously adopted, the whole Corporation to be a committee to carry out the resolution.

Electrical Trades' Union Demonstration. —On Saturday, says the *Manchester Examiner*, a demonstration took place at Belle Vue, in this city, of the Electrical Trades' Union, a labour organisation which is composed of workmen who follow the following occupations in connection with electrical industries: Dynamo winders, erectors and tenders, installation linesmen and wiremen, indoor and outdoor, battery and accumulator makers, fitters and inspectors, telegraph and telephone wiremen and linesmen and labourers who are employed in either telegraph, telephone, or electric light construction and maintenance. About 200 sat down to tea, and a short meeting, which was afterwards held, was presided over by Councillor G. D. Kelly, secretary of the Manchester and Salford Trades Council. A number of letters of apology for non-attendance were read from members of Parliament and other gentlemen who expressed their sympathy with the objects of the union. The chairman said he knew of no trade in which a union was required more than in their particular trade. His idea of a trades union and the benefits that should come to the men composing it was advanced wages, reduced hours, and better conditions of labour altogether. Some of the men who composed the new unionism regarded a trades' union simply as a fighting machine. That was not his view. His impression was that if they wanted to gain any lasting benefit it would not be by pulling off their coats and fighting the employers, but by going on safe and constitutional lines, and with the greatest respect and courtesy approaching their employers to bring about those changes which they desired to see effected. They must not be led away by plausible talk into taking steps that they were not prepared to take, but before advancing they must always be sure of their ground, and be in a position to step back again if it was necessary. Another function of trades unionism was that of encouraging each other, so that each man should not live selfishly for himself. He noticed with pleasure, and as one of the signs of the times, that a gentleman who was an official of the company which employed many of those he was addressing was present. He urged the men to cultivate a good feeling between their officers and themselves, and so conduct themselves that the officers would respect their union. He was glad to see the efforts which were being put forward for the organisation of female labour. Such an organisation was required. He knew of one place in the city where if a woman earned 6s. a week there were deductions and fines to such an extent that it was rarely that she could get out of the place with more than 4s. 9d. And that sum meant 10 or 12 hours work a day for six days a week. How could a woman live respectably on such a pittance as that? When a woman's labour came into competition with that of a man the latter's wages always went down, but they ought to see to it that where such competition was unavoidable the woman got as much as the man. They were trying to start a women's trade union, and he invited all women workers, no matter what their occupation was, to join it. On the motion of Mr. H. Burgess, seconded by Mr. C. H. Ormsby, a resolution was adopted calling upon all electrical trade workers to join the union. A vote of thanks to the chairman terminated the proceedings.

PROVISIONAL PATENTS, 1892.

OCTOBER 3.

17593. **An improved detachable electric lamp jointing for removable lamps for shop fronts and similar situations.** William Richard Wynne, 3, St. Nicholas buildings, Newcastle-on-Tyne. (Complete specification.)

17600. **A new or improved automatic electric switch.** Francis Harrison, 54, Fleet street, London.

OCTOBER 4.

17643. **Improvements in electric switches.** Henry Edmunds, 47, Lincoln's-inn-fields, London.

17647. **Improvements in magneto-electric appliances.** Harry Hylton Foster, 76, Chancery-lane, London. (Complete specification.)

17653. **An improved process for treating cups, separating partitions or diaphragms, used in electric batteries or electrolytic apparatus.** Anton Joseph Lehman, Monument chambers, King William-street, London.

17691. **Apparatus for the cutting of glass by electricity.** Leon Havaux, 323, High Holborn, London.

OCTOBER 5.

17698. **A new or improved polarised electrical indicator.** Henry Frederick Lewis and Harris Henry Eley, 2, John street, Bristol.

17700. **An improvement in electric arc lamps.** Edwin Charles Russell, Jeffrey's-square, London.

17717. **Improvements in connection with electrical machines and coin-freed mechanism therefor.** Henry Johnson Avery and Eugene Morand, 13, Temple-street, Birmingham.

17718. **Improvements in or relating to electrical and mechanical telephone receivers.** Henry Rose, 46, Lincoln's-inn-fields, London.

17743. **Improvements in arc electric lamps.** Ernest de Pass, 78, Fleet-street, London. (Louis Bardon, France.) (Complete specification.)

17751. **A door lock switch for electric lights.** George Frederick Redfern, 4, South-street, Finsbury, London. (Charles Green, Canada.) (Complete specification.)

OCTOBER 6.

17774. **Improvements in dynamo-electric machines and in their applications to secondary battery installations.** Edward Woodrowe Cowan and William Paul James Fawcus, Brackland, Vicarage-lane, Bowdon, Chester. (Complete specification.)

17826. **A method of transforming alternating electric currents of any tension into continuous currents also of any tension, and conversely and apparatus for that purpose.** Maurice Hutin and Maurice Leblanc, 28, Southampton buildings, Chancery-lane, London.

17855. **Improvements in electrical distribution.** Thomas Tomlinson, 24, Southampton buildings, Chancery-lane, London.

OCTOBER 7.

17877. **Improvements in regulators for dynamo-electric machines.** Thomas Reginald Andrews and Thomas Preece, 20, Charles-street, Bradford.

17878. **Improvements in the method of and apparatus for starting electric motors.** Thomas Reginald Andrews and Thomas Preece, 20, Charles-street, Bradford.

17895. **Improvements in apparatus for the manufacture electrolytically of tubes and other articles of circular section.** Francis Edward Elmore, 28, Southampton buildings, Chancery-lane, London.

17909. **Electric switches.** Charles Ebenezer Challis, 30, Navarino-road, Hackney, London.

17922. **Improvements in secondary batteries.** Frank King and Edward Clark, 47, Lincoln's-inn-fields, London.

17930. **Improvements in secondary batteries.** Julius Hirshfeld, William Morison, Andrew Patterson Morison, and William Wright, 165, Broadway, New York, U.S.A.

17931. **Improvements in battery compounds.** Julius Hirshfeld, William Morison, Andrew Patterson Morison, and William Wright, 165, Broadway, New York, U.S.A.

OCTOBER 8.

17973. **Improvements in electrolytic tanks.** James Charles Richardson, 23, Claremont square, London.

17974. **Improvements in plating metallic surfaces and also prepared surfaces of non-conducting substances by electro-chemical deposition.** Pascal Marino, Ashburn House, Esher, Surrey.

17982. **Improvements in brushes for electric current generating and receiving machines.** Alfred Julius Boult, 323, High Holborn, London. (Louis Boudreaux, France.)

SPECIFICATIONS PUBLISHED.

1891.

15705. **Electric signalling on railways.** Walkinson and Frem.

16076. **Coin freed telephonic system.** Wrattisch and Vergaceovica.

18162. **Electrical lamp, etc., fittings.** Gover.

19211. **Electric meters.** Teague and Moy.

19625. **Electric lighting.** Grundy.

19778. **Electric lighting apparatus.** Dawbarn.

19854. **Dynamo brushes.** Dickson and Shapcott.

19914. **Electric arc lamps.** Barton. (Jandus.)

20139. **Electric signals.** Gent and others.

1892.

11952. **Electric meters.** Jones.

13639. **Mechanical telephones.** Simpson.

14014. **Secondary batteries.** Fell. (Morrison.)

14558. **Incandescent electric lamps.** Dorman and Smith.

14738. **Electric arc lamps.** Cooper.

14822. **Incandescent electric lamps.** Lake. (McOuat.)

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	[illegible]
Brush Co.	-	[illegible]
— Pref.	—	[illegible]
City of London	—	[illegible]
Electric Construction	10	[illegible]
Gatti's	-	[illegible]
House-to-House	5	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]
London Electric Supply	5	[illegible]
Metropolitan Electric Supply	—	[illegible]
National Telephone	[illegible]	[illegible]
St. James'	—	[illegible]
Swan United	[illegible]	[illegible]
Westminster Electric	—	[illegible]

NOTES.

American Electric Railroads.—The number of electric railroads has increased this year from 385 to 469.

Elgin—On Tuesday, owing to an accident at the gas works, the whole town of Elgin was plunged in darkness.

Electric Cooking.—Messrs. Crompton are bringing out a new electric oven to supplement the other electric cooking appliances shown by them.

Bristol.—The Corporation of Bristol have appointed Mr. H. Faraday Proctor, of Newcastle-on-Tyne, to be clerk of the works for their electric lighting installation.

Curious Strike.—It is stated that the workmen of the Popp Compressed Air Company, of Paris, are intending to strike in order to obtain the reinstatement of M. Victor Popp.

Electric Organs.—The Hope-Jones electric action is being applied by Messrs. Norman Bros. and Beard to the following organs: Hastings, All Souls' Church; London, St. Frideswide's Church; Liverpool, Presbyterian Church, Sefton Park; Blackheath, Christ Church.

Domestic Lighting.—We have received a copy of "Domestic Electric Lighting Treated from the Consumer's Point of View," by Ed. C. de Segundo, A.M.I.C.E.; a paper-covered book of 115 pages, price 1s.; published by Alabaster, Gatehouse, and Co., 22, Paternoster-row, E.C.

Industrial Electricity.—A work has recently been published by F. Rouge, Lausanne, entitled "Couro d'Electricité Industrielle," 15 lectures given to the engineers of the Jura-Simplon Railway by A. Palaz, professor of electricity at the Lausanne University; 416 pages, with 350 illustrations.

Albert Palace.—The anonymous donor of over £10,000 to the Albert Palace Polytechnic is understood to be Mr. J. Passmore Edwards, the wealthy and philanthropic proprietor of the *Echo* and other papers. Several public buildings in Cornwall have recently been built and endowed by the same generous benefactor.

Association Francaise.—At the meeting of the French Association for the Advancement of Science at Pau a new accumulator was brought forward by Edouard Peyrusson. Drs. Gautier and Larat gave a paper on alternate currents and their therapeutic application, and Dr. Gautier another on "interstitial electrolysis."

Institute Dinner.—It has been decided by those in authority that at the dinner of the Institution of Electrical Engineers, which is to take place on the 18th of November, the speeches will be kept short, and at a comparatively early hour those present will adjourn to a smoking-room to listen to music and to talk with their friends.

Technical Index.—An index to all the articles in the English and American technical press has been compiled, to be issued monthly, price 1dol. a year, by the "Engineering Magazine" Company, New York. Any inventor who is working out a special problem can see in this index what current articles are being given on his topic.

Chicago World's Fair.—The Siemens and Halske Company of America have prepared plans for an electrically lighted theatre, in which "Columbus balls," in old-fashioned costumes with electrical effects, will be held in Chicago. A novel idea is a spiral tower, 560ft. high, which will have an electric railway running around it to the top, and a platform 200ft diameter will give plenty of space for promenade and a good view.

Resistance and Self-Induction.—A paper has been reprinted and sent to us from the *Philosophical Magazine* for September on "Equivalent Resistance, Self-Induction, and Capacity of Parallel Circuits with Harmonic Impressed E.M.F.," by Frederick Bedell and Albert C. Crehore, PhD.'s, of Cornell University. The equations give equivalent resistance and capacity of parallel circuits containing resistance and capacity only.

Old Students.—The annual dinner of the City Guilds Old Students' Association will be held on Friday, October 28th, at 7 30 p.m., at the Holborn Restaurant. It is expected that this will be the most representative gathering of Old Students that has yet taken place. Tickets, 5s. each, can be obtained of the hon. sec., Mr. E. B. Vignoles, 28, Lanhill-road, Elgin-avenue, W. Music will be given by Messrs. FitzGerald, Emerson, and Jacoby.

Chamber of Commerce.—A meeting of the Electrical Trades Section of the London Chamber of Commerce will be held on Friday, the 21st inst., at 3 p.m., at the offices, Botolph House, Eastcheap. The following points will be considered: Chicago Exhibition; County Council Overhead Wires; Arbitration; Standardising of Machinery; Uniformity of Prices; and Foreign Competition. With such an interesting agenda, the attendance should be good and the discussion lively.

Tramway Starter.—An invention which might conceivably be of use also in mechanically propelled cars, has been designed by Mr. J. F. Fide, of the Bombay Mint, for doing away with the strain on tramcar horses at starting. The invention consists of a ratchet wheel fixed to the axle of the car, worked in connection with a lever, and it is stated effects nearly 50 per cent. reduction in the strain of starting. The appliance automatically throws itself out of gear as soon as the car has gone a distance of 18in., and can be adapted to other vehicles.

Employment Register.—The London Chamber of Commerce employment register has proved very successful, we learn from the secretary's report. Anyone who wishes to engage a clerk, linguist, secretary, or traveller can obtain good men by consulting this register. A list of persons open to undertake agencies in different parts of the world is also kept. It has been suggested that the Chamber should organise a labour bureau for the kingdom, and this desirable proposal is under discussion, and suggestions will be received by the secretary.

Infancy or Manhood.—The meeting of the Londonderry Corporation last week was memorable in the history of electric lighting, as being the first recorded instance where a member of a town council—Councillor Magee, chairman of the Electric Lighting Committee—actually used the words "The electric light is not in its infancy." We have been so often told, and are even now told from time to time, of the "infancy" of the electric light, that it is worth recording that at last the definite idea of the vigorous manhood of the new illuminant is acknowledged by the men who used to carp against its introduction.

London Association of Engineers and Draughtsmen.—A paper was read by Mr. R. J. Bott, before the society, on "Electricity from the Supply Company to Consumer." Mr. Bott divided the types of central stations into three categories—slow-speed machines and very large dynamos, the continental practice, high speed machines and very high speed dynamos, the American common practice, and high-speed engines coupled direct to dynamos, the usual English practice, of which the latter was, he thought, the preferable. He described low-tension feeder and high-tension transformer systems, and was awarded a cordial vote of thanks for his interesting paper.

Cabstand Telephones.—A subscriber to the telephone system writes to the *Leeds Mercury* to make a suggestion

which would be of great service to all subscribers to the telephone, and a good source of profit to cab proprietors—that the public cabstands should be attached to the telephone; this would enable subscribers at once to call a cab from the nearest stand. There are about 16 private stands already in connection in Leeds, it appears, but not a single one of the public stands. The value of telephone connection is a matter that should at once have the attention of cab proprietors, and, indeed, it might be quite worth while to have a public call box as well at each cabstand.

Cannes.—The direction of the electric lighting station at Cannes has been taken by M. Grivolas, of Paris, whose name is well known with reference to electric appliances. The large number of visitors who pass their winters in Cannes, and are not afraid of their pockets, makes this a suitable place for a splendid installation. Up to the present there are 6,000 lamps lighted, and it is expected over 8,000 will be required this season. There are two Ferranti alternators of 120,000 watts each, and three continuous-current machines, with large batteries of accumulators. Two steam engines of 200 h.p. and one turbine of 180 h.p. supply power, and no failure of the light has occurred.

Cathedral Lighting in Vienna.—St. Stephen's, the famous cathedral of Vienna, and one of the finest and largest Gothic structures in the world, was for the first time lighted by electricity at Sunday's service. A trial of the new light was made on Saturday in the presence of Cardinal Archbishop Gruscha, and proved very successful. Twelve arc lamps are used, each of 1,000 c.p., being distributed over the church, four in each of three naves. The effect was quite dazzling, the smallest architectural and decorative details being visible. In some respects, of course, this was not wholly an advantage, the brilliancy of the light being certainly less impressive that the "dim religious light" of the former method of illumination.

Telephotography.—It has been the dream of electrical men that photographic scenes could be sent by electrical means to a distance. According to recent advices the method of doing this has been perfected, and H. E. de Ville, a Paris gentleman, is now in Chicago in the interest of a syndicate which proposes to flash accurate photographs of the World's Fair over the wires, and have them reproduced on a large scale on a canvas background in the various cities, by means of a system of telephotography. M. de Ville refers enquirers into the system to an article that appeared in the Paris *Figaro* some three years ago, commenting on the experiments of M. Henri Courtonne, a French chemist. It sounds rather chimerical.

New Books.—Messrs. Whittaker and Co. will issue next week a new work by Mr. Allsop, entitled "Practical Electric Light Fitting," a treatise on the wiring and fitting up of buildings deriving current from central station mains, and the laying down of private installations, including the latest edition of the Phœnix Fire Office rules. The work will be fully illustrated. They expect to have ready also Part 1. of Mr. Maycock's new "Elementary Manual of Electric Lighting and Power Distribution," for students preparing for the ordinary grade examination of the City and Guilds of London Institute and general readers; copiously illustrated with original diagrams, and with questions and ruled pages for notes.

Electric Sculptor's Tool—The sculptor's electric reciprocating tool, invented by Mr. W. P. Carstarphen, of Denver, is coming into practical use. It would constitute a valuable application of portable storage batteries, for it only requires two or three cells giving four to six volts and eig[illegible] amperes of current. A stonecarver can do as much with this tool in a day as four or five men with chisels and mallets. It weighs about 6lb., has reciprocating coils, switch on and off by the motion of the chisel itself, and the stroke can be regulated by a button from ¼in. to 1in., while the rapidity can be varied from 300 to 600 strokes per minute. A company is being formed at Denver to manufacture this invention, which is likely to be of great usefulness to sculptors and masons.

Electric Light Staff.—The work at the Manchester square station is divided into three watches of eight hours each on weekdays, and two watches of 12 hours on Sunday. This plan, which was originally designed by Mr. Gordon for the Paddington installation, has since been adopted in a number of other places. The weekday watches are from 7 a.m. to 3 p.m., from 3 p.m. to 11, and from 11 until 7 a.m. As there are only two watches on Sunday, the men are shifted in their watches every week, so that a man employed on the first watch one week is on the second watch the following week, and on the third the week after that. Each man works on an average 56 hours a week—first week 60, second week 60, third week 48 hours, and he gets completely off every third Sunday.

Nepaul (India).—The grand electric light installation that has been in course of execution since last year, in the new summer palace of H.H. the Maharaja Beer Shumsher, Prime Minister of Nepaul, at a cost of about a lakh of rupees, has just been brought to a successful completion. There are 250 16-c.p., and 10 300-c.p. incandescent lamps, and one 40,000-c.p. search-light in the circuit. On the first experiment in lighting being made, the search light threw out such a flash of light that the whole valley was more or less illumined. The work has been very creditably carried out, says the *Indian Engineer*, by Mr. Lester Betts, electrician to the great Silvertown firm of electrical engineers—the India Rubber, Gutta Percha, and Telegraph Works Company—whose branch house in Calcutta undertook the work of installation.

New York and Chicago Telephone.—The direct telephone line between New York and Chicago, which was tested on Tuesday, is the longest in use up to the present. A wire giving direct talking communication with Buffalo has been used for some time, but that city is only about half the distance of Chicago from New York. The new line is 950 miles, less a furlong, in length. It runs through Harrisburg, Altona, Pittsburg, Youngstown, Toledo (Ohio), and Southbend (Indiana). The wire weighs 435lb. to the mile, and is ⅛in. in diameter. If the line between New York and Chicago is found profitable, it will be extended to San Francisco. Prof. Bell is very sanguine as to the financial result of the enterprise. He declared on the occasion of this test that in his opinion the whole civilised world will be eventually connected by telephone.

Lecture at Manchester.—Prof. Silvanus Thompson delivered a highly interesting technical lecture on "Magnetic and Electric Fields," in the Manchester Town Hall on Monday, by arrangement with the Technical Instruction Committee. The large hall was crowded. The Mayor of Manchester presided, and in introducing the lecturer spoke of the high position electricity now occupied. They, in Manchester, had spent a large sum of money in fitting up a school for the study of electricity. Electricity had been applied to the telephone, the telegraph, and the light, and they were all glad to receive information as to the development of the science. Prof. Thompson, in the course of his lecture, dealt largely with the space surrounding magnetised bodies, and illustrated his remarks by many interesting experiments. The lecture was followed with deep interest, and at its close Prof. Thompson was accorded a hearty vote of thanks.

Electric Light Current in a Clock.—In Berlin the other day, recounts the *Daily News*, a workman was boring a hole in a wooden wall in order to put in a screw, when he received a strong shock, and, ignorant of the cause, he left the gimlet in the hole and fled. At the same time the electric clock of the "Urania" opposite the house suddenly stopped, and the electricians who manage the clock for a long time could not imagine what was the matter. The workman while boring had pierced the thin wooden wall and the lead covering of the electric cable which regulates the Urania clock, and at the same time slightly touched an electric light cable with his gimlet. In this way a communication was established between the two cables, and the strong current from the light cable was led into the clock cable, when proving far too strong for the clock, it stopped the works.

The Telephone in France.—The Administration of Posts and Telegraphs, which a short time ago took over the telephones in France, has just published a very interesting report, according to which there are now 112 towns in France provided with telephone communication. These towns represent a population of over six millions, this being nearly a sixth of the total population of France. When the State took over the telephones, there were only 11,440 subscribers, whereas there are now 18,191, rather more than half of whom are in Paris. But while this gives a proportion of only one subscriber to 253 inhabitants, there are several other towns in which the proportion of subscribers is much higher, being 1 in 215 at Mentone and 1 in 120 at Cannes, while in several of the large industrial towns of the North there are also relatively more subscribers than in Paris. The total received from subscribers for the past year was £210,960, of which nearly two thirds was derived from Paris.

Giraud Thermopile.—Each of the elements of the Giraud thermopile is formed of an alloy, whose exact composition is made to vary with the size of the element, so that the E.M.F. may remain constant without the internal resistance increasing. The following are the three types of electrodes which are found to be the most advantageous: A (small type), length 70 mm., width 20 mm., height 20 mm. ($2\frac{3}{4} \times \frac{3}{4} \times \frac{3}{4}$in.); composition in parts by weight: antimony 1,450, zinc 900, cadmium 50, pure copper 80, tin 40, silicium 3. B (ordinary type), dimensions 70 × 20 × 30 mm.; composition: antimony 440, zinc 780, cadmium 60, pure copper 30, tin 15, silicium 2. C (large type), 70 × 30 × 50 mm.; composition: antimony 1,830, zinc 960, cadmium 65, silicium 2. The other electrodes are composed preferably of plates of tinned iron or of pure nickel; but these electrodes, it is stated, may also be of iron, plated on the surface with either iridium, platinum, or nickel, or may be of ferro-aluminium. The two electrodes are soldered together at the moment of the fusion of the alloy.

House of Lords.—Hitherto the House of Lords has lagged behind the House of Commons in the matter of electric lighting. Now, however, the hereditary legislators will be better provided for in this respect than the members of the Representative Chamber. Ten electroliers, each containing 36 16-c.p. lamps have been made, and when these are in position it is believed that the House of Lords will be one of the best lighted buildings in London. The candelabra on each side of the Throne will be allowed to remain, but the old gas pendants are being taken down, and electricity will be the illuminant for all practical purposes. The apparent backwardness of the House of Commons in this connection is not due to any want of enterprise on the part of the Office of Works. The central hall, the members' lobby, the dining-room, smoking-rooms, library, and reading-room, and most of the corridors and private apartments have been lighted by electricity for some time, as well as the reporters' gallery. But in the House of Commons itself the system of gas illumination and ventilation are so interdependent that the suppression of the gas would seriously impair the efficiency of the ventilation.

Edison Patent.—The trial in the great American incandescent lamp case, which has extended from court to court for over 12 years, has now been suddenly decided fully in favour of Edison, who thus obtains control over the lamp manufacture, with a right of exacting royalties for past manufactures. It is too early to learn how the General Electric Company (which owns the Edison patent) is going to act, but the back royalties are stated by their attorneys to amount to over 15 million dollars. There are about 20 incandescent lamp makers in the States besides the Edison factory, though the latter produces 40 per cent. of the whole. The questions now being asked are whether licenses will be granted or whether the General Electric factories will be increased to cope with the monopolised demand. The Thomson-Houston clique have benefited the most by this decision, for they have by their amalgamation with the Edison Company avoided the necessity of fighting, and now possess a more valuable property than was bargained for. Possibly if the decision had come a year ago, no amalgamation would have taken place. It is not thought that drastic measures will be taken, though no declaration of policy is yet announced.

Another Swindle. — We have heard of "bottled lightning," but the Hungarians have got hold of the bottler. The Pesth correspondent of the *Montags-Revue* says that "a professor" from America has been travelling through the provinces to interest the peasant farmers in his new invention, which he calls the "lightning trap," and to get orders for his electrical "traps." The professor erects tall poles, which attract the lightning, and by means of a system of wires he collects the electric sparks in small caskets, the walls of which are so constructed that the bottled lightning is isolated and preserved in a fresh and lively condition. It can be carried about from place to place, and so utilised for agricultural purposes that any farmer can have what he so often wants, a shower of rain upon some particular field, while all the fields around continue dry. "The professor" caught and imprisoned no fewer than 14 flashes of lightning during the storms of August. Unfortunately, the Hungarian police authorities are less accessible to new scientific ideas than the country peasants. The American professor has been treated by them as he proposed to treat the lightning—"caught and imprisoned for the profit of the agricultural population." He is now in jail as a swindler.

Belfast.—The special correspondent of the *Belfast Evening Telegraph*, who has been writing a careful set of articles on the various London electric light stations, has interviewed Mr. J. E. H. Gordon. Mr. Gordon, as is known, has done a great deal of work in Ireland already. He has a special desire, says the correspondent, to spread the light in darkest Ireland, and has suggested that in Belfast the Corporation ought to drive an electric light station by means of gas engines. It would be expensive to use the purified gas, but the "rubbishy gas" which is not at present sent out to customers might be used. As the Corporation own the gas works, it would be to their advantage to proceed on this basis. He favours the direct-current system for this town, and considers the cost should be about £30,000 for an installation. The commissioner of the *Belfast Evening Telegraph*, in the issue of October 17, gives a long and full description of the Kensington and Knightsbridge central stations, erected by Messrs.

Crompton and Co. There will be in all 22 articles, we are told, appearing day by day, on electric light in London and the provinces, and we should fancy the readers of this paper will be amongst the best informed on the present status of electrical engineering of any, outside technical readers, at this present day.

Electro-Harmonic Society.— The next smoking concert of the Electro-Harmonic Society will be held on Friday, October 28, at the St. James's Hall Restaurant (Banquet-room), Regent street, W., at 8 o'clock. Artistes: Master Frank Barnes, Mr. Walter Coward, Mr. Harper Kearton, Mr. R. E. Miles; violin, Mr. T. E. Gatehouse; piano, Mr. Alfred E. Izard; humorous selections, Mr. Robert Ganthony, musical directors, Mr. T. E. Gatehouse and Mr. Alfred E. Izard. Programme: Part I.—Glee, "Hark! hark! the lark" (Cooke), Master Frank Barnes and Messrs. H. Kearton, W. Coward, and R. E. Miles; Spanish scena, "The Night Watch" (Pinsuti), Mr. R. E. Miles; pianoforte solo, "Scherzo, Op. 20" (Chopin), Mr. Alfred E. Izard; song, "Two Messengers of Love" (Forrester) Master Frank Barnes; violin solo, (*a*) "Romance" (Svensden) (*b*) "Pizzicati" (Delibes), transcribed by Marsick, Mr. T. E. Gatehouse, scena, "Adelaida" (Beethoven) Mr. Harper Kearton; burlesque lecture, "The Funnygraph," Mr. Robert Ganthony. Part II. Part song, "In this Hour" (Pinsuti); ballad, "Sometimes" (S. Forbes), Mr. R. E. Miles; violin solo, "Rapsodie Irlandaise" (Hauser), Mr. T. E. Gatehouse; duet, "Excelsior" (Balfe), Mr. Harper Kearton and Mr. R. E. Miles; song, "Sweet Nightingale" (Boscovitch), Master Frank Barnes; song, "Zanita" (H. Trotere), Mr. Harper Kearton; musical sketch, "Recollections," Mr. Robert Ganthony.

Grounded Low-Pressure Wires.—The most recent advices from America show that there is a conflict between the electric light companies and the Board of Underwriters. It seems that the Board of Underwriters notify that on and after October 1st no more grounded wires would be approved of by the Board. It is said that all the companies have complied with this order except the Edison Company. Many of the firms who are being supplied by Edison incandescent circuits are declaiming against what they term the arbitrary proceedings of the Board of Underwriters. They are not quite sure whether their policies will hold good or not, and say that if the Edison system was not dangerous before Oct. 1, why is it held to be dangerous now? There is a good deal in this contention, but it must be recollected that fire insurance companies have to take care of themselves, and if they find the risks increase they are bound to show some signs of this and to make new rules. We, however, are strongly of opinion that in this case the Board of Underwriters are in a false position. Still, our readers are more concerned with English practice than with American practice, and we think it is admitted, even on that side of the Atlantic, that we have paid greater attention to everything that concerns safety, and are more careful in carrying out our work with due precaution, than they are on the other side.

The Central Institution.—Of the 109 candidates who recently entered for the matriculation examination at the Central Institution, Exhibition road, 73 passed, and six did sufficiently well to be allowed to join the college as unmatriculated regular students. In addition to these 79 thus admitted, each to attend courses in all the four departments of mathematics and mechanics, engineering, physics, and chemistry, and those who, having been admitted in previous years, have not yet completed their course, some 40 special students have joined the advanced courses in one or more of these departments, thus bringing the total number of students at the Central Institution up to the maximum for which it was intended. On the result of this entrance examination the Clothworkers' Scholarship of £60 a year, with free education for two years, and renewable for a third, was gained by W. G. Bennett, from the Bancroft School; the Mitchell Scholarship of £30 a year for two years, with free education, by E. W. Hummel, from the Finsbury Technical College, the Clothworkers Technical Scholarship of £25 a year for two years at the Finsbury College, and £30 a year for three years at the Central Institution, both with free education, by W. C. Maers; and four Institute's Scholarships of sufficient value to cover the fees for three years, by M. J. P. O'Gorman, from the Royal University, Dublin; W. T. Gidden, Bancroft School; and A. D. Constable and W. A. Davis, both from St. Dunstan's College, Catford. At the end of the last session the John Samuel Scholarship of £30 and free education for a third year's student, was awarded to H. C. Leake; and the Siemens Medal to C. V. Drysdale.

Communication with Lightships.—Mr. Hobbs, of Ramsgate, the promoter of the scheme for telegraphic communication between lightships and the shore, writing to a Dover correspondent, states that he is officially informed that the report of the Royal Commission, which will be presented after the meeting on the 19th inst. will recommend that the Goodwin lightships be telegraphically and telephonically connected with the shore, the East Goodwin lightship being connected with Dover. The work will be carried out on Lucas's patent system. A system of telegraphic communication on shore is also being rapidly pushed forward on the south-east coast. At Ramsgate and Margate some of the wires are already laid in connection with coastguard stations, and arrangements are being made to connect various points with the North Foreland on the one side and Deal on the other, while similar arrangements are being made at Hythe and New Romney, so that the dangerous coast line between the North Foreland and Dungeness will soon be provided with ready means of inter communication. It is understood that the system will, as soon as possible, be extended round the entire coast. The Royal Commission upon electrical communication between lighthouses, lightships, and the shore met again on Wednesday, the Earl of Mount Edgcumbe presiding. All the members were present except Mr. Munro Ferguson. Evidence was received from the masters of the following lightships: North Lasbor, near Cromer; Woold, Cross Sand, Ship Wash, Kentish Knock, North and East Goodwins, and from Mr. Williams, district officer of coastguards at Aldborough. The Commissioners are meeting again to receive further evidence, and it is their intention to issue shortly an interim report.

Electric Railways.—To reside some 60 to 100 miles away from one's place of business would seem to be an easy probability for the future citizen, if the electric high speed railways do all they are expected to accomplish. Instead of a town being a centralised aggregation of houses, we may return to the old long, straggling high-street of a century ago, but on an extended scale. Boulevards are to stretch away from the so-called towns, lined with trees and secluded houses. They will be lighted by electricity, and fitted with motors and heaters. Between the lines of houses will stretch a long straight road of double or triple lines of railway, the centre rails for high-speed express trains, the outer for stopping trains, while outside will be a carriage road fitted with electric trams. The resident will take his tram, run to the nearest station, go by train to the express stopping place, and from there be whisked to his destination, the whole distance up to 60 or 100 miles being done within the hour. Our towns will approximate to the

geometrical notion of a line—length without breadth. Every man can live in his own domain with plenty of fresh air. The entire line will be enclosed, the carriage crossings going over and the railway lines under. The New York *Electrical Engineer* gives a bird's-eye view of such a scheme, which is to be carried out in practice at once for the St. Louis and Chicago Railway. The order has been placed for the electrical equipment of the first car to the specification of Dr. Wellington Adams, the builders guaranteeing a pair of motors to develop the required power to run the cars at the specified speed of 100 miles an hour. The best electrical engineers and the best established financial houses in America and Europe are understood to have promised their assistance, with a view of completing within the specified time this bold enterprise, which, when carried out, cannot but give an immense impetus to electric traction enterprises throughout the world.

The Telephone System in Switzerland.—The Geneva correspondent of the *Economiste Français* states that the increase in the number of telephone lines since the new tariff came into operation, about two years ago, has been very remarkable. Previous to that, there were 61 telephone lines, with 6,944 speaking stations and a revenue of about £44,000, the annual subscription being £6, with no limit to the number of conversations. The new tariff lowered the subscription to £3. 4s. (80f.), and the result is that at the beginning of the present year there were 101 telephone lines, with 12,595 speaking stations, this being equivalent to an increase of 81 per cent. The length of lines is 3,225 miles, while there are 13,340 miles of wires, the principal lines being those of Geneva (2,176 stations), Zurich (1,712), Basle (1,522), Lausanne (806), Berne (753), and St. Gall (596). The total number of messages between residents in the same town was 6¾ millions, while there were 687,000 conversations exchanged between different places. The new law stipulates that each subscriber shall be entitled to only 800 conversations in the course of the year, and pay ½d. for each one over that number, but over 78 per cent. of the subscribers kept within the prescribed limits. Although the total receipts amounted to £65,400, the expenses incurred in putting down new lines and increasing the staff were so great that the net receipts were about 4 per cent. less than in the year previous to the passing of the new law, but for all that the profit derived by the State is so large that these expenses will soon be paid off, and a surplus will soon be available. The development of telephone communication has, says the *Times*, as might be expected, checked the increase in telegraphic communication, the number of telegrams showing only a fractional increase upon those of the previous year, while it is anticipated that there will this year be an actual decrease.

Electric Spark Photography.—Mr. C. V. Boys, F.R.S., assistant professor at the Royal College of Science, delivered the second Gilchrist lecture in connection with the university extension at Reading last week, on the subject of "Electric Spark Photography," the Mayor being in the chair. The lecturer first explained the speed of the electric spark. He then showed photographs taken by Lord Rayleigh, by means of the electric spark, of various soap bubbles in the act of bursting, and explained the process, the photographs showing that various bubbles did not break at exactly the same rate (about 30 miles a minute). Another photograph showed the issue of liquid from a very small pipe, which to the naked eye appeared a perfect stream, but which on an electric photograph being taken, was resolved into a beautiful and regular series of drops; and in this connection the lecturer remarked that the science of liquid volumes and of the forces which had to do with the surface of liquids was one of the most interesting branches of physical science. As they probably knew, playing or singing to a fountain suddenly changed its appearance from drops into one, two, or three apparently separate clear streams of liquid, but a photograph shown, taken as a tuning-fork was struck, demonstrated that the water was disposed, in drops, in a beautifully regular fashion. Mr. Boys went on to deal with photographs of bullets in motion, showing first a picture of a rifle bullet going at the rate of 2,000ft. a second, and this, being taken by the ordinary electric spark, was considerably blurred. If it were wished to investigate what was really happening when a rifle bullet was passing through the air, it was necessary to illuminate with something even more instantaneous than the electric spark. For the purpose of investigating the duration of the electric spark, he had caused to be made a mirror of steel about the size of a shilling, so mounted as to revolve with ease, without getting hot, at the enormous speed of about 1,000 turns per second, and the end of the beam of light given off from the mirror passed across the screen at a rate he hardly liked to mention; but practically the photographs he was about to show were taken by that apparatus (which was not his invention, but was devised by Germans) in about one ten-millionth part of a second. Special attention was directed to the varying formation of the air waves created by the progress of bullets from a pistol, a Martini-Henri, and a Winchester rifle, respectively, which were compared with the vibrations in the air caused by sound. These experiments, which were all fixed by photography, were clearly shown on the screen, and excited much interest. Some 50 years ago Mr. Russell Scott prepared a series of most important diagrams relating to water waves, and by pictures the lecturer showed that air waves precisely corresponded. Photographs were next shown exhibiting the appearance of charges of shot from cylinder and choke bore barrels of a gun; and, in conclusion, half-a-dozen pictures taken as a bullet was passing through a sheet of plate glass, showing in the most marvellous manner the whole phenomenon from beginning to end, the pictures and their explanation being loudly applauded. Mr. Boys said they might ask why he had chosen such an extraordinary subject to lecture on as the photographing of bullets. He knew nothing of bullets himself—and probably they did not—and he did not care much for photography. All that was of interest in the present subject, from his point of view, was this—that there was a certain difficult thing which was of interest to a certain class of people, and it was interesting to try by some means or other to solve that problem. By the use of means which were by no means complicated, but which were, as he had shown, almost ridiculous in their simplicity, a problem which some would say was altogether beyond the reach of experiment had been solved with absolute ease and certainty. One could find out by scientific method things which would be said at first to be absolutely impossible of discovery; and when one began to find out those secrets one was always rewarded by coming across curious and unexpected phenomena, which formed the bases of scientific discovery. The knowledge that very often their preconceived ideas would get knocked on the head by coming across the unexpected, formed the fascination and delight of the scientific experimentalist; and therefore he had chosen that subject as a simple and fairly intelligible example of the experimental art. The lecture was received with the greatest interest.

PRACTICAL INSTRUMENTS FOR THE MEASUREMENT OF ELECTRICITY.

BY J. T. NIBLETT AND J. T. EWEN, B.Sc.

IX.

(Continued from page 2..9.)

RESISTANCE *continued.*

Dial Forms of Wheatstone's Bridge.—There is another class of Wheatstone's Bridge, similar in construction to the Post Office form, but very different in the arrangement and value of the coils in the known variable resistance. Instruments of this class are termed dial forms or rectangular forms of Wheatstone's Bridge, according as the resistances are arranged in circles, as in Figs. 18, 19, and 20, or in pairs of parallel lines, as in Figs. 21 and 22. In both of these forms the known variable resistance is arranged in sets of nine coils all of the same value, the sets themselves increasing in powers of ten. Thus, in the different examples shown in Figs. 18, 19, 21, and 22, the coils comprising the known variable resistance are as follows:

nine coils of 1 ohm each,
,, ,, 10 ohms ,,
,, ,, 100 ,, ,,
,, ,, 1,000 ,, ,,

and in the example of a dial instrument shown in Fig. 20, there are in addition to these

nine coils of $\frac{1}{10}$ ohm each,
and ,, ,, 10,000 ohms ,,

The manner in which the coils are arranged, and one method of connecting up the unknown resistance R, the galvanometer, the battery, and their keys, is illustrated in Fig. 19, which is a diagrammatic representation of the instrument shown in Fig. 18. From Fig. 19 it will be seen that each dial consists of 10 massive metallic junction pieces numbered consecutively from 0 up to 9, and arranged in circular form round a metal centre-piece which is connected by a thick underboard copper strip or wire to the zero junction piece of the next dial.

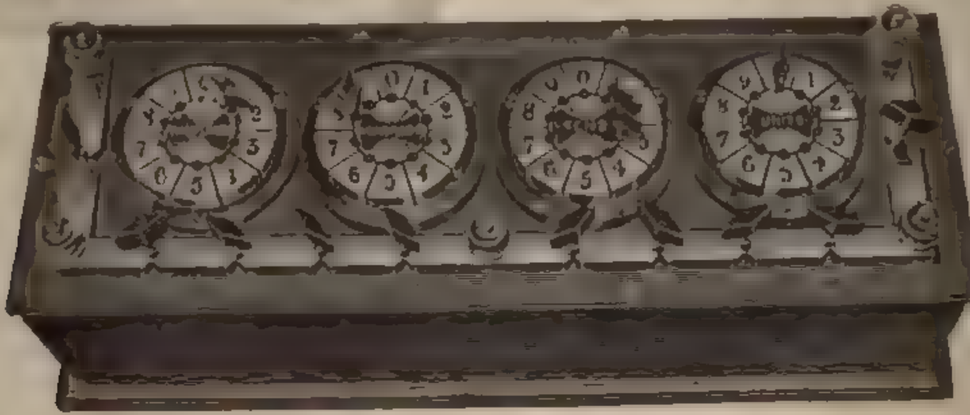


FIG. 18.—Wheatstone's Bridge, Dial Pattern.

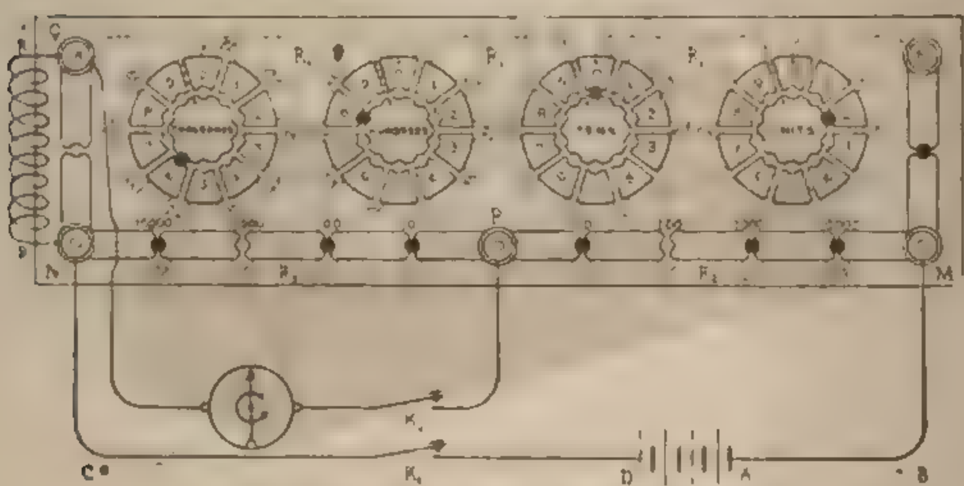


FIG. 19.—Diagram of Wheatstone's Bridge, Dial Pattern.

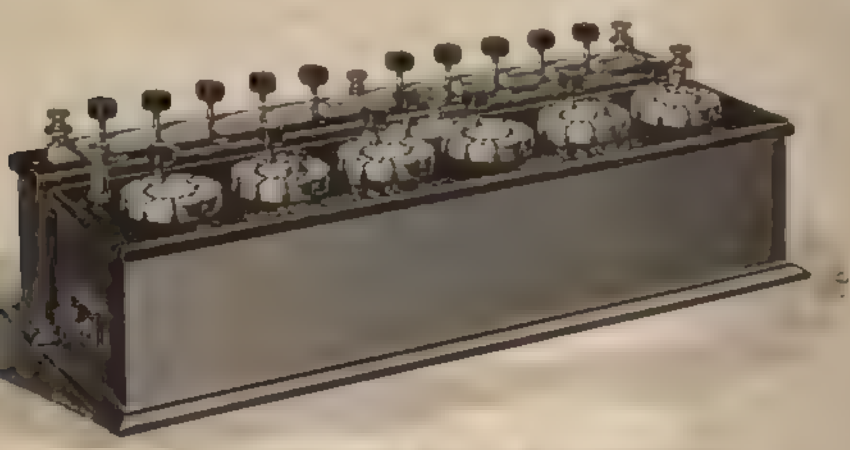


FIG. 20.—Wheatstone's Bridge, Dial Pattern, with Detachable Ratios.

The two ratios, R_2 and R_3, each consisting in this example of four coils of 10, 100, 1,000 and 10,000 Ohms, are ranged along one side of the instrument, and from their ends M and N project two arms as shown, each provided with an infinity plug for breaking the circuit. The zero junction piece of the units dial and the central piece of the thousands dial are connected to the extremities of these arms by thick underboard copper strips or wires, as indicated by the dotted lines in Fig. 19.

The advantages of this method of grouping the coils, over the earlier modes will be at once evident. Only one plug is necessary for each dial, and the readings are direct, the number of coils through which the current must pass in each dial being indicated by the number on the junction piece against which the plug is inserted. Thus, the reading of the dials in the instrument shown in Fig 18 is 2,850 Ohms, while that in Fig. 19 is 6,802 Ohms. With the arrangement represented in Fig. 19, if the galvanometer shows no deflection when the keys are closed, then the value of the unknown resistance R will be found as follows:

$$R = R_1 \times \frac{R_2}{R_3},$$

$$= 6{,}802 \times \frac{1{,}000}{100},$$

$$= 68{,}020 \text{ ohms.}$$

Another example of the dial form of Wheatstone's Bridge is shown in Fig. 20, which illustrates an instrument in which the ratios R_2 and R_3, and the known variable resistance R_1 are contained in separate boxes, connection being made, when desired, by stout copper wires or strips as shown in the illustration. In this case, each of the two ratios consist of five coils of 1, 10, 100, 1,000, and 10,000 Ohms; and the known variable resistance comprises six dials ranging from tenths of an Ohm to ten thousands of Ohms, the maximum reading being 99,999·9 Ohms, or practically 100,000 Ohms. There is an infinity plug situated about the centre of the six dials, and as both of the brass pieces for this plug are provided with screw terminals as shown in the illustration, this plug can also be used for dividing the coils into two separate groups of three dials each.

This instrument, as well as the one illustrated in Fig. 22, is provided with what is known as a Hockin and Taylor's thermo-coil, of which the clamp terminals are shown in the illustrations, projecting from the end of the known-variable-resistance box. This device consists of a coil of insulated copper wire wound round about the coils of the known variable resistance so that it may readily acquire the same temperature, and it is so adjusted that its resistance is exactly 100 Ohms for the temperature at which the coils in the box are right (17·0° C., in the case of the instrument shown in Fig. 20). Then as this thermo-coil is of pure copper, its resistance when the temperature changes will vary differently from that of the other coils, so that if a measurement of this resistance be made, using the bridge in the ordinary way, the correction for temperature can be got from the result obtained, by means of a table of constants. The instrument is also provided with holes for the insertion of thermometers to ascertain the temperature of the coils during a measurement. The exact temperature for which the coils have been adjusted is usually marked on the instrument, so that a correction for temperature may be readily made when desired.

FIG. 21.—Wheatstone's Bridge, Rectangular Pattern.

Figs. 21 and 22 are two examples of the rectangular pattern of Wheatstone's Bridge, an arrangement due to Dr. Muirhead. This is simply a variation of the dial pattern of bridge; the junction-pieces of the coils being disposed five on either side of a long brass block, instead of the whole ten being arranged in a circle. The internal arrangements and connections are the same for instruments of both patterns. Besides being a neater and more compact class of instrument than the dial pattern, the rectangular pattern also affords much greater facilities for cleaning the contacts and spaces between the junction pieces. In the example shown in Fig. 21, the known variable resistance and the ratios are all contained in one box, whilst in the case of Fig 20 the ratios are detachable as in the six-dial instrument, Fig 20, and a Hockin and Taylor's 100-Ohm pure copper thermo-coil is also added.

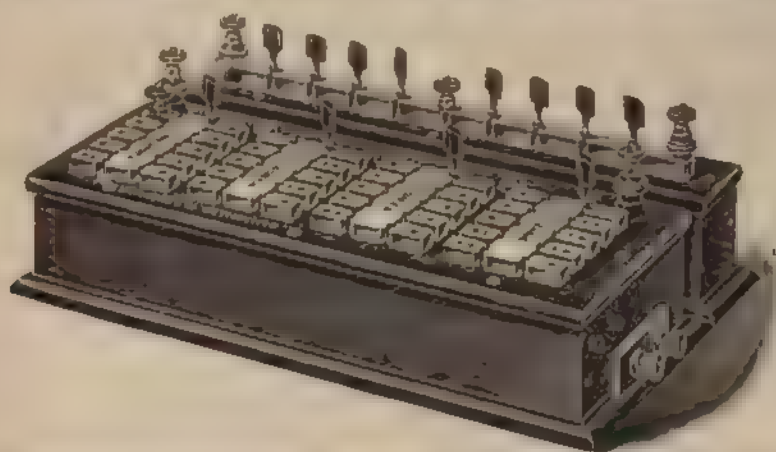


FIG. 22.—Wheatstone's Bridge, Rectangular Pattern, with Detachable Ratios.

Figs. 18 and 20 are examples of dial instruments, the former made at Silvertown Works and the latter by Messrs. Nalder Bros.; and Figs. 21 and 22 illustrate two instruments of Dr. Muirhead's rectangular pattern, the former made by Messrs. Nalder Bros., and the latter at Dr. Muirhead's works.

(To be continued.)

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

III.—WORK AND HORSE-POWER.

(Continued from page 351.)

Since the cylinder encloses the piston, the diameter of it (internally) is that of the piston.

$$\text{Area} = \frac{\pi d^2}{4}, \text{ where } d = \text{diameter,}$$

$$\text{and } \pi = 3{\cdot}1416.$$

$$\therefore \text{Area} = \frac{3{\cdot}1416 \times 81}{4} = 63{\cdot}61 \text{ square inches.}$$

Let the length of the stroke be 11in., then for the forward and backward stroke the total length will be 11 × 2 = 22in. = 1·83ft.; speed is 200 revolutions per minute, pressure is 80lb. per square inch. Thus we have

$$P = 80,\ L = 1{\cdot}83,\ A = 63{\cdot}61,\ N = 200,$$

or,
$$\frac{80 \times 1{\cdot}83 \times 63{\cdot}61 \times 200}{33{,}000} = \text{I.H.P.} = 56{\cdot}4.$$

Hence the engine will yield 56·4 I.H.P.

When the engine is compounded the steam is admitted into the small high pressure cylinder first, and the exhaust steam, which now has a very much lower pressure, say one sixth of the initial, then goes into the low pressure, or large cylinder, so that two calculations must be made and added together—one for the work done in the high-pressure cylinder, and the other for the work done in the low-pressure cylinder.

Example.—In a compound engine the diameters of the high and low pressure cylinders are respectively 10in. and 25in. Steam is admitted to the high at 100lb. pressure per square inch, and to the low at 16lb. pressure per square inch. Speed is 160 revolutions per minute, and length of stroke is 14in. Find the indicated horse-power.

The power developed in the high-pressure cylinder will be calculated first.

$$\text{Area of piston} = \frac{3{\cdot}1416 \times 100}{4} = 78{\cdot}54 \text{ square inches.}$$

$$P = 100,\ L = 2\text{ft. }4\text{in.},\ A = 78{\cdot}54,\ N = 160;$$

therefore

$$\frac{100 \times 28 \times 78{\cdot}54 \times 160}{33{,}000 \times 12} = 88{\cdot}85 \text{ I.H.P.}$$

For the low-pressure cylinder we have

$$\text{Area of piston} = \frac{3{\cdot}1416 \times 625}{4} = 490{\cdot}87 \text{ square inches.}$$

therefore

$$\frac{16 \times 28 \times 490{\cdot}87 \times 160}{33{,}000 \times 12} = 88{\cdot}85 \text{ I.H.P.}$$

The power in each cylinder is thus the same, which it must be; so that adding the two together gives the total power of the engine, or

$$88{\cdot}85 + 88{\cdot}85 = 177{\cdot}7 \text{ I.H.P.}$$

For triple-expansion engines, where three cylinders are used, the same process may be adopted.

Mechanical Equivalent of Heat.—Heat is a form of energy, and no work can be done without the production of heat. A revolving wheel contains kinetic or stored up energy, and if suddenly stopped by applying a brake, heat is at once produced, due to the tremendous friction that exists. It was of the utmost importance to know the relation that exists between the unit of heat and the unit of mechanical energy. This want was supplied by Joule, who conducted most elaborate experiments for six years in order to obtain accurate results. The chief method used by Joule was concerning the friction of fluids, and he obtained his data in the following way. A number of paddles were delicately suspended in a vessel of water, a length of string was wound round the spindle of the paddles, passed over a pulley, and then attached to a weight. Upon allowing this weight to fall, rapid motion was given to the paddles, and the great agitation of the water raised its temperature. The mechanical power was obtained by multiplying the known weight by the distance it fell, and the equivalent amount of heat created was measured by the rise of temperature of the known mass of water.

These experiments established without doubt the following law connecting heat and work: *The amount of energy produced as heat is an exact measure of or is equal to the amount of energy expended mechanically.*

Joule found that the work expended by allowing a mass of 424 grammes to fall by gravity a distance of one metre would produce sufficient heat to raise the temperature of one gramme of water through one degree centigrade, say, from 9deg. C. to 10deg. C.). This amount of heat is fixed upon as the unit of heat, and is called a Calorie. Since one gramme falling one centimetre = 981 ergs of work, therefore 424 grammes falling one metre = 981 × 424 × 10², or 41,594,400 ergs, so that one Calorie of heat may be taken to be the equivalent of 42,000,000 ergs of work done. It was shown that one watt, the practical unit of power, was equal to 10,000,000 ergs of work done per second; therefore power, or rate of doing work, can be expressed in heat units, and one calorie per second $= \frac{42{,}000{,}000}{10{,}000{,}000} = 4{\cdot}2$ watts,

or, 1 Watt = ·24 Calorie per second.

In electrical work this last formula is a very important one, for by its use, as will be seen later on, it enables the electrician to calculate the extent to which electric mains and branch wires, and also the coils of dynamos, motors, etc., are heated, when a given amount of watts of electrical power is passing through them. It is a formula that should be constantly in the mind, because the production of electricity and its distribution, whether in the form of Light or Power, is invariably accompanied by Heat. Electricity, Heat and Light, all three, are closely identical in their phenomena. From electricity, heat and light are produced; from heat, electricity and light are produced; from light, electricity and heat are produced. Magnetism also exhibits phenomena that lead us to identify it to some degree with the above three, because from magnetism electricity can be produced, and also heat. As an example of this latter statement, take the case of a bar of iron, which will become rapidly heated by magnetising it by means of an alternating current of electricity. With respect to the relations between magnetism and light, we have Maxwell's "Electromagnetic Theory of Light." This theory arose from the belief of electricity and magnetism being produced by motion of the ether (the ether being the name given to that which is supposed to pervade all bodies and all spaces), the same with regard to the propagation of light rays. An extraordinary fact is that the velocities of propagation of electromagnetic induction and of light are so close to each other as to be almost identical, the velocity of electromagnetic induction being 2·9857 × 10^{10} centimetres per second, and the velocity of light being 2·9992 × 10^{10} centimetres per second. A practical result of this identity is that whenever any disturbances of the sun's surface take place, magnetic disturbances immediately take place on the earth's surface, and affect the working of telegraphic apparatus.

It is useful to know the mechanical equivalent of heat when expressed in English units. The English unit of heat is that amount of heat which will raise 1lb. (pound) of water from 60deg. F. to 61deg. F., or 1deg. F., and the mechanical energy required to produce one unit of heat is the work done by a weight of 1lb. falling by gravity through a distance of 772·55ft., or, in other words, 772·55 foot pounds.

Hence 772·55 foot pounds = one unit of heat. This amount of mechanical energy is known as "Joule's equivalent," or by the letter "J."

The following tabulation gives values of Force, Work and Power expressed in English and French Units of Weight and Length.

TABULATION 9.

FORCE.

1 Milligramme weight represents (nearly)	..		1 dyne.
1 Gramme	,,	,,	981 dynes.
1 Pound	,,	,,	444,000 ,,

WORK.

1 Milligramme centimetre does work = (nearly)			1 erg.
1 Gramme centimetre	,,	,, =	981 ergs.
1 Foot pound	,,	,, =	13,562,850 ,,

POWER.

10^7 Ergs per second	=		1 watt.
1 Kilogramme metre per second	=	(nearly)	10 watts.
1 Foot pound ,, ,,	=		1·35 ,,
75 Kilogramme-metres ,, ,,	=	French H.P.	736 ,,
550 Foot pounds ,, ,,	=	English H.P.	746 ,,

Running Cost of Steam Engines.—Granting 4lb. of coal to the brake horse power per hour, with coal at 20s. per ton the cost of 1 b.h.p. per hour works out to ·43 or ½ penny; at 15s. per ton, to ⅓ penny; and at 12s. per ton, to ¼ penny. This is for coal alone, which varies in price according to the

locality. Other expenses, as oil, wages, water, etc., can be taken as fairly constant in price. It is very difficult to predict the annual cost of motive power; there are so many varying items which depend on local circumstances. An approximate idea can be given, however, which may be found useful. There are also great differences existing in the working expenses of engines of various sizes which are altogether out of proportion, and another great controlling feature is the number of hours per annum run; here, again, the expenses are out of proportion. A third very important point relates to the load an engine is working at; the more an engine works towards its full load the less is its proportional cost. An example will now be given of the probable annual running cost of a steam plant giving 40 b.h.p., working at full load, and running 10 hours per day, or about 3,000 hours per annum. The total cost can be divided into two equal parts, one of which will represent depreciation, interest, repairs, and wages. This half may be regarded as a fixed amount, independent of what the running hours may be. It may be argued that only wages and interest should be held as of fixed value, since the wear and tear will vary the depreciation and repairs. Strictly speaking, this is correct, but, to simplify matters, it is assumed that they remain constant. The other half of the total cost is put down to coal, oil, waste, water, and sundries—the cost of an engine and boiler, including a fair estimation for the expenses of properly fixing same, being taken at £15 per Brake Horse-Power, or £600 for 40 b.h.p.

TABLE I.

A.—INVARIABLE COSTS.

	B.H.P. per annum.	B.H.P. per hour.
Interest on outlay, £600 at 4 %	£0 12 0	·048 penny.
Depreciation „ „ 7½ %	1 3 0	·092 „
Repairs „ „ 5 %	0 15 0	·060 „
Wages of driver, £100 per annum	2 10 0	·200 „
Total	£5 0 0	·400 penny.

B.—VARIABLE COSTS.

4lb. of coal per hour for 3,000 hours, using coal at 15s. per ton	£4 0 0	·32 penny.
Water, oil, waste, and sundries	1 0 0	·08 „
Total	£5 0 0	·40 penny.

So that total cost per Brake Horse-Power per annum = £10.
and „ „ „ „ hour = ·8 penny

If the above plant be used for working the electric light, the running hours will be very much shorter. Take an average time, say from dusk until 10 p.m., this will be about 1,500 hours throughout the year, including Sundays. This is one-half of the preceding case, but the cost will not be one-half, because part of the total cost remains constant, and this amount is £5 per brake horse-power per annum. The other part of the cost will now be in proportion to the hours run, so we have $\frac{5 \times 1,500}{3,000} = 2\frac{1}{2}$. Thus the total cost for 1,500 hours = £7. 10s. per brake horse-power per annum, or 1·2 pennies per brake horse-power hour. If the hours were shorter the proportional cost would be greater, and if longer it would be less. When the cost per hour works out very small, then the plant is said to possess great earning capacity, and this applies to all machinery, whether steam engines, gas engines, dynamos, or what not. This point is a very serious question in central electric light stations, for the expensive plant has to be idle all day, and is only earning money on an average of half a dozen or so hours per day out of the 24.

We will now investigate the running cost of small sized steam engines. The outlay is higher per horse-power in the first place, say £20 per brake horse power, or £200 for a 10 b.h.p. steam plant, wages remain same. The economy will be less, so that 25 per cent. more for coal, oil, etc., must be allowed than for the larger plant.

Tabulating these results, we get

TABLE II.

A.—INVARIABLE COSTS.

	B.H.P. per annum.	B.H.P. per hour.
Interest on outlay, £200 at 4 %	£0 16 0	·120 penny
Depreciation „ „ 7½ %	1 10 0	·064 „
Repairs „ „ 5 %	1 0 0	·080 „
Wages of driver, £100 per annum	10 0 0	·800 „
Total	£13 6 0	1·064 pence.

B.—VARIABLE COSTS.

5lb. of coal per hour for 3,000 hours, using coal at 15s. per ton	£5 0 0	·4 penny.
Water, oil, waste, sundries, etc.	1 5 0	·1 „
Total	£6 5 0	·5 penny.

So that total cost per Brake Horse-Power per annum = £19. 11s.
and „ „ bour = 1·56 pence.

This is just about double the working cost of the large plant per Brake Horse-Power Hour, or looking at it from another point of view, the large plant will yield four times the power at only double the cost, since 40 × £10 = £400, and 10 × £20 = £200

Now let this small plant run for only 1,500 hours per annum, we have £13. 6s., which remains constant, and a proportional cost for the rest. That is

$$\frac{6\frac{1}{4} \times 1,500}{3,000} = £3\tfrac{1}{8} = £3.\ 2s.\ 6d.$$

and £3. 2s. 6d. + £13. 6s. = £16. 8s. 6d. per annum. This is equal to 2·9 pence, or nearly 3 pence, per brake horse-power per hour.

(To be continued.)

ELECTRIC POWER IN MINING.*

BY IRVING HALE.

There is a genuine fascination in the modern applications of electricity to the needs of business and social life—to the transmission of messages over continents and seas by means of the telegraph; to the transference of the human voice, with all its individual peculiarities and inflection, through the telephone; and to the illumination of cities by electric currents distributed from a single station. But none of these appeal as strongly to the imagination as the transmission of power by this mysterious force. When we watch a ponderous engine, with its strong rods and cranks of steel and massive flywheel, anchored to a foundation of solid masonry to resist the vibrations produced by its mighty efforts, it is easy to appreciate the enormous power that is being developed; but when we are told that all this power is required to revolve a bundle of wires in the open space between the poles of a magnet, and that in those wires nine-tenths of this mechanical energy is converted into electrical energy and passes out of the building on a few small wires which undergo no strain and give no visible evidence of the work that is being done within them, and that this electric energy can be transmitted for miles and reconverted into mechanical power, we cannot fail to be impressed with the remarkable nature of this transformation and the possibilities which it involves.

The advantages of producing power where it can be done at comparatively small expense, either with water power or cheap coal, and transmitting it to places where water power is not available and fuel is expensive, are so evident as to require no discussion, and it is obvious that there are few places offering better fields for such operations than the mining districts, where water power is generally available within a few miles, but seldom at the mine or mill, and where the cost of coal is almost always great. Moreover, electricity is peculiarly adapted to underground work, where steam is objectionable on account of inconvenience of pipes, loss by condensation, and heat produced, while the transmission of power by compressed air is inconvenient, expensive, and wasteful.

Indeed, so striking are the advantages and possibilities of electric transmission of power that there has been a strong tendency to exaggerate and to allow the spirit of prophecy to override conservative judgment. For instance, while it is theoretically possible to run the factories of Chicago by power transmitted from Niagara Falls, and while it is possible that a small plant of this kind may be installed at the World's Columbian Exposition as an illustration of what can be accomplished, still in the present state of the art such an enterprise would not be commercially feasible, nor is it likely, with all the improvements

* From the *Engineering Magazine*, New York.

that will be made for many years to come, that the power of Niagara will be felt beyond a radius of a hundred miles. It is not intended to imply that this distance is necessarily the limit of successful and profitable transmission of power by electricity. It is quite possible that in the near future plants may be in commercial operation over even greater distances, but they will be in localities where fuel is sufficiently expensive to make the saving pay interest on the large investment required.

The question is frequently asked, "How far can water power be successfully and profitably transmitted by electricity?" The answer depends upon many conditions. In one situation it might not pay to transmit power a mile, while in another it might be transmitted 50 miles and pay large dividends on the investment. The principal conditions affecting this question are the cost of water power, cost of fuel where power is to be used, amount of power required and number of hours used per day, and, lastly, the voltage or electrical "pressure" that can be employed satisfactorily. When it was discovered that the dynamo, which generates an electric current when its armature is revolved by some extraneous power, becomes a motor and will do work when a current is sent through it from another dynamo, and that this action can take place regardless of the distance between the two machines, the feasibility of transmitting power by electricity was at once recognised. In the enthusiasm over this discovery and its possible effects there has been quite a general tendency to overlook the important question of dollars and cents, which is the criterion by which the fate of every purely engineering or business enterprise must be determined. The manner in which the financial aspect of the question is affected by distance, voltage, and the other conditions named can be more clearly shown by a brief examination of some of the principles governing electric transmission of power.

The total efficiency of an electric-transmission plant (ratio of power delivered on motor pulley to power required to run dynamo) is usually between 60 and 70 per cent., there being a loss of 10 or 12 per cent. in converting mechanical into electrical energy in the dynamo, a similar loss in reconverting electrical into mechanical energy in the motor, and a loss in the line depending on the relation between the size of wire and the current transmitted. This line loss (due, not to leakage, which is insignificant in a properly-insulated line, but to the waste of energy in overcoming the resistance of the conductor) may be made as small as desired, no matter how great the distance, by using sufficiently large wire, but this involves additional expense, and it is evident that for each case a point will be reached where farther increase in size of wire would be inadvisable, as the interest on additional cost of copper would exceed the value of the power saved. In most cases the best loss in line, all things considered will be between 10 and 20 per cent., which, with the losses in dynamo and motor, will give a total efficiency of 60 to 70 per cent.

The energy lost in line is dissipated in the form of heat, and the amount of energy so dissipated is equal to the square of the current multiplied by the resistance of the wire, this law being expressed by the equation $H = C^2 R$, in which H represents energy converted into heat (measured in watts), C represents current (in amperes), and R resistance of wire (in ohms). As the resistance of a wire varies directly as its length and inversely as its cross-section, this resistance (and consequently the line-loss) will increase with the distance, unless the cross-section of wire is increased as rapidly as its length, which means that the weight of wire will increase as the square of the distance, and that its cost will soon become prohibitory. To keep the weight of wire constant as distance increases, the area of cross section must be correspondingly decreased which will make the resistance increase as the square of the distance. To keep the line loss constant, the equation shows that C^2 must be correspondingly decreased, which requires it to vary inversely as the square of the distance or C to vary inversely as the distance. How can this be done and still transmit the same amount of power? The answer to this question is suggested by the formula for the energy of an electric current, W (energy) = C E, E representing E.M.F., commonly called voltage or "pressure," measured in volts. This equation shows that the same energy may be transmitted by a small current, provided the "pressure" is correspondingly increased (an analogy to water power), and from what precedes it is evident that, if the E.M.F. increases in the same ratio as the distance, a given amount of energy can be transmitted with the same loss and the same total weight of wire, regardless of the distance.

This apparent avenue of escape from the difficulties of long distance transmission is again blocked by the objectionable features of the high voltage or "high tension" current, chief among which is the difficulty of manufacturing dynamos and motors which will be proof against the almost uncontrollable desire of such current to puncture insulating materials, produce "short-circuits," "grounds," and "burn-outs," and make uncalled-for pyrotechnic displays around the commutator.

A partial solution of this difficulty is expected from the "three phase" system recently experimented upon in Germany, where power was successfully transmitted from Lauffen to Frankfort, a distance of 108 miles. In this system the dynamo generates an alternating "three phase" current of large "quantity" and low "pressure" or voltage, which is converted by a transformer into a current of small quantity and enormously high voltage — 20,000 to 30,000 volts if necessary — that can be transmitted over a comparatively small wire and reconverted at the other end into a low voltage current which operates the motors. The advantage of very high voltage in transmission is secured while avoiding its disadvantages in dynamos and motors. While the Lauffen Frankfort installation was a scientific experiment rather than a commercial enterprise, still the results obtained are regarded as very encouraging, and the development of this method is expected to exert a powerful and beneficial influence on long-distance transmission. It must not be forgotten, however, that the transformers at both ends of the line add materially to the cost of the plant, and that the pole line and labour for such a distance, regardless of size of wire, become a serious item of expense, and that consequently electric transmission to very long distances must still be limited to cases where fuel is comparatively expensive and the saving is sufficient to pay interest on the required investment.

The foregoing discussion shows how the distance to which power can be transmitted profitably is affected by the question of voltage. The other conditions mentioned as affecting this problem require no detailed discussion, as it is evident that the saving effected by water power over steam will be greater when water power is cheap, fuel dear and the work continuous, than when reverse conditions exist, and that the greater this saving the greater will be the justifiable investment in electric plant and the distance to which power can be profitably transmitted.

Equations and curves have been deduced showing in a general and approximate manner the cost and operating expenses of electric transmission plants and the limits within which they will be profitable (pay 20 per cent. on investment) under various conditions. A few examples may be of interest here. If coal costs 4dol. per ton and power is used 10 hours per day, 200 h.p. can be electrically transmitted four or five miles at 1,000 volts E.M.F. and pay 20 per cent. per annum on the investment. If used steadily 24 hours per day, it can be transmitted 11 or 12 miles under the same conditions. If 2,000 volts can be conveniently used, these distances will be nearly doubled; in fact, the limiting distance will increase almost in proportion to the voltage employed. Looking at the question from another standpoint, it may be shown that if coal costs 6dol. per ton at a mill where 100 h.p. is used 24 hours per day, and water power can be developed at moderate cost at a distance of five miles from the mill, and there is no objection to using an E.M.F. of 2,000 volts, the saving effected by using electric power will pay 50 to 60 per cent. per annum on the cost of the plant. If, however, this mill is in a locality where slack coal can be obtained for 1dol. per ton, and power is used only 10 hours per day, it would not pay to instal an electric plant if water power could be had within a quarter of a mile, as the saving would not pay interest on cost of water power, dynamo, and motor, without any line

whatever. Examples might be multiplied indefinitely, but the instances mentioned are sufficient to show how impossible it is to give a general answer to the question, How far can power be profitably transmitted by electricity? and how necessary it is to carefully weigh all existing conditions. The cases cited show, however, that, whatever may be the limiting distance to which power may eventually be transmitted profitably by electricity, there is at present a wide field for enterprises of this kind, presenting an attractive investment for capital, and nowhere are the advantages of electric power more striking than in the mining districts.

Aspen, Colorado, is entitled to the name of the pioneer camp for electric mining machinery. The first electric hoist was installed there in 1888, and consisted of one of the earliest types of Sprague street-car motor geared to a flat friction hoist. It has been in use ever since, and is still giving satisfactory service. There are now at Aspen five electric hoists, three electric diamond drills, three electrically-driven blowers for ventilating, a 20-h.p. motor running the sampling works, and several smaller motors used for various purposes, while many of the mines are lighted by incandescent lamps. The Aspen Mining and Smelting Company operates its own plant, consisting of two 50-h.p. dynamos supplying current for three hoists, one diamond drill, one motor driving a blower, and another running a machine shop, as well as lights for the tunnels and workings. The other electric machinery, together with more than a hundred arc lights and nearly 3,000 incandescents for town and mines, are supplied from the plant of the Roaring Fork Electric Light and Power Company, which is one of the most interesting on the continent, and is a good example of the mountain style of water power and electric plant.

The mining town of Aspen is situated on Roaring Fork at its junction with Hunter Creek, a small stream that tumbles down the ravine on the north-west side of Smuggler Mountain, on which are situated such famous mines as the Smuggler, Johnston, Della S., and the fabulously rich Mollie Gibson. On Hunter Creek, about 2½ miles from its mouth, a small dam is built, the principal objects of which are to give a sufficient body of water to avoid stoppage by surface and anchor ice and rubbish, and to provide a small reserve of water to tide over the early morning hours, when mountain streams fed from the melting snows are lowest. From this dam extends a flume 24in. by 18in., a distance of 9,000ft. to a point on Smuggler Mountain, 876ft. above the power-house, which is located near the bank of Roaring Fork a little above the mouth of Hunter Creek. From the end of the flume a wrought-iron pipe 4,500ft. long extends straight down the mountain and across the gentle slope at its foot to the power-house, where it supplies water through nozzles to eight 2ft. Pelton wheels, rated under this head of 876ft. at 175 h.p. each, which run the dynamos for supplying light and power. In the small view of the power-house is also shown the waterwheel governor, designed by Mr. Doolittle, manager of the company, which, by means of differential gearing, utilises the difference in speed between a wheel with steady load and the wheel to be governed to move the nozzle of the latter wheel and vary the amount of water delivered against the buckets.

The quiet little stream flowing from the power-house gives no indication of the vast power that it has just been the means of generating, but this power can be appreciated by raising the covers from the wheels and looking at the water as it is hurled from the nozzles against the buckets, and if any further evidence of its terrific force be required, it can be obtained by attempting to pinch one of these little jets between the thumb and forefinger. The spray on its surface presents a velvety feeling to the touch, but when the fingers have sunk into the jet $\frac{1}{16}$in. it is as hard and impenetrable as if it were frozen, and it is said to be impossible to cut it with an axe.

Probably the most remarkable electric plant in the country, all things considered, is the one at the Virginius mine, near Ouray, Colorado. The water power is located on Red Cañon Creek nearly four miles from the mine, which is near the top of Mount Sneffles, far above timber-line in the region of perpetual snow, and at an altitude of 12,700ft. above the sea. The idea of transmitting this water power to the mine by means of electricity, at a time when such an undertaking was regarded as a somewhat doubtful experiment, was very forcibly suggested by the fact that coal had to be packed to the mine on burros and cost delivered about 20dol. per ton, or 100dol. per day for the amount of power used at that time.

The power plant is similar in its general features to the one at Aspen, just described. From the power-house the line extends for some distance up the cañon through dense timber, where the wires are subject to the danger of falling trees blown down by the terrific wind-storms which prevail in that locality. Leaving the cañon, the wires are carried up a precipitous bluff, ornamented here and there with the carcases of burros which have slipped or been crowded from the narrow trail known as "the zigzag," effectually disproving the commonly-accepted theory that it is impossible to kill a burro. From timber line, at the top of this bluff, the line is built across a rocky plateau, where the snow during the first winter covered the tops of some of the poles, which were at that time only 20ft. high, but which have since been replaced by longer ones. For the last half-mile or so the poles are set along the base and on the sides of high cliffs, to avoid as far as possible the destructive snowslide. The current is carried down the mine by the best waterproof cables, boxed for mutual protection of wires and men, the electric pressure, 800 volts, being a little too strong to suit the taste of the average miner. The power, about 250 h.p. in all, is distributed among two pumps, one hoist, one blower, and two mills. It will be seen that this plant comprises nearly all kinds of machinery employed in mining operations, and encounters every difficulty to which electric plants are heir, including the worst enemy of electric machinery, lightning, in its most violent form. It is not surprising that troubles were experienced in the early operation of the plant, but the gratifying facts that these have been remedied and that the plant is running in a perfectly reliable and satisfactory manner are evidence that electricity in mining has come to stay.

It is a conservative statement that there are, in Colorado alone, hundreds of mines using steam power produced by very expensive fuel that are sufficiently near to good water power to be operated by electricity at a saving that would pay from 40 to 100 per cent. per annum on the investment, and it is not a wild prophecy to say that within the next three years scores of such plants, developing thousands of horse-power, will be installed.

The effect of such enterprises will be powerful and widely felt. By decreasing the cost of mining and treating ores, mines which now pay will pay better, while many properties which, on account of low-grade ore or remoteness from railroads and fuel supply, cannot now be worked without a loss can be made by means of electric power to yield satisfactory profits. The effect will be to increase the metal output, give employment to more men, build up the mining towns, exert a beneficial reflex influence on the commercial cities, and, in general, benefit the entire mining districts.

Next to the silver question, the introduction of electric power is at present the most important factor affecting the development of the mining industry, and, unlike free coinage, electric power is not dependent on legislative action, but is entirely under the control of the mining men themselves.

Electrolytic White Lead.—The chairman of one of the largest white-lead companies, on being questioned recently, said that "nothing had yet upset the good old method" of obtaining white lead. Numerous experimenters are, however, on the track for the fortune that awaits the lucky inventor of a better and cheaper process is immense. The process of M. Stevens recently described for obtaining white lead electrolytically is as follows: To water is added 300 cubic centimetres of nitric acid to make a volume of two litres. The anodes are plates of lead 3 mm. thick. If the metal contains silver, the silver is deposited on the cathode, and can be separated. By passing a current of carbonic acid the white lead is precipitated.

THE

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EDISON'S PATENT RE INCANDESCENT LAMPS.

The exact position with regard to incandescent lamp patents is becoming more and more interesting every day, both here and in America. In this country, however, opposition manufacturers to those controlling the Edison-Swan-Sawyer patents are a thing of the past, and would-be producers are waiting with what patience they can command the lapse of the patents. In America the case has been somewhat different. Legal fighting in regard to the Edsion patents has been going on for years, and it is only within the past few days that the decision in the appeal case Edison Electric Light Company v. The United States Electric Lighting Company, has been given in favour of Edison. The patent of Edison under dispute is No. 223,898, filed November 4, 1879, and granted January 27, 1880. The four claims of the patent are as follows:

"1. An electric lamp for giving light by incandescence, consisting of a filament of carbon of high resistance, made as described, and secured to metallic wires, as set forth.

"2. The combination of carbon filaments with a receiver made entirely of glass, and conductors passing through the glass, and from which receiver the air is exhausted for the purposes set forth.

"3. A carbon filament or strip coiled and connected to electric conductors so that only a portion of the surface of such carbon conductors shall be exposed for radiating light, as set forth.

"4. The method herein described of securing the platina contact wires to the carbon filaments and carbonising of the whole in a closed chamber, substantially as set forth."

In our article on September 30, when discussing the lapse of the Cheesbrough patent, No. 4,847, November 28, 1878, we spoke of Edison, Swan, and Sawyer as a triumvirate to which was due the commercial incandescent lamp of to-day. Nine-tenths of the litigation on patent questions is caused by the frailty of humanity, the inherent longing which every human being seems to possess of putting his hands into his neighbour's pockets. A new departure was given to incandescent lamp making with the introduction of filaments and flashing. Immediately satisfactory results were known, hundreds of "so-called inventors" set to work to see if they could devise an "improvement" which they could patent, and so get round the patent of the original inventor. Not one of these hundreds had knowledge or sense enough to start an investigation *de novo*. They were simply sheep following the bell-wether. They commenced to make and sell lamps, and the pioneers had to fight for their rights. In England case after case was fought and won. In America case after case had to be fought, the final result being delayed till now. There are two people the world should delight to honour, but in most cases the attempt is to rob—give all honour to the initiator or initiators of a new departure that confers benefit to poor humanity, and give as great honour to the man or men who make that departure commercially practicable. We do not include in this latter category company-mongers, who are the sharks in the sea of civilisation. It may be that Edison and Swan have reaped great

pecuniary advantages, but surely the world and the electrical industry have nothing to declaim against this, seeing that the one has obtained "subdivision," and the other has participated in the gains of an industry which is destined to be without equal in the world's history. Without incandescent lighting central stations would never have come into general existence. The views relating to power transmission and the utilisation of electric energy in every household would for years, if not for centuries, have remained in abeyance. Thus we think that the law both in America and in England has, whatever its tediousness and intricacies, come to a right decision in the end. If the monopolists were wiser in their generation, they might, however, have legislated more for the future than for the present.

A NEW SYSTEM OF MAINS.

We understand that Messrs. J. E. H. Gordon and Co. will probably next week make public, through the medium of the technical press, their new system of mains, devised by Mr. Tomlinson, which it is thought may go a good way towards reducing the cost of copper in conductors. From the moment that incandescent lighting became practical, it was seen that the cost of copper in mains would form a large item in the initial expense of central station work. Originally we had a lead and a return. Then Prof. John Hopkinson on this side of the Atlantic, and Mr. Edison on the other side of the Atlantic, devised the three-wire system — or the *n*-wire system whereby a large amount of copper might be saved. This system might well be called a differential system, and it is in common use throughout the whole world. We do not know how the new system is to be named — probably, however, by the best known name of the company under whose auspices it is brought out. By its means it is hoped that the third wire in the three-wire system may be saved, reducing the mains to two, as in the oldest form; but with the great advantage of saving a large amount of copper over the original system.

Of course, there is some little difficulty in deciding the value of a new departure till full details are known, and these depend upon Patent Office formalities. We are told that the system has been tried successfully, and that the important feature is in the use of a one-to-one transformer, which, so to speak, acts as a balance. Those who have carefully examined the cost of this, as compared with other systems, are confident that it will effect a very great saving, and must be extensively adopted. It is quite evident to all who know anything about central station work that every pound saved initially will greatly assist extensions. This saving, however, must not be at the expense of efficient maintenance, for, as we have so often contended, an extra initial expense is as nothing compared with the constant drain of inefficiency. There seems, however, no doubt as to the gain both initially and without detriment hereafter in everything that tends towards perfection in mains.

CORRESPONDENCE.

"One man's word is no man's word.
Justice needs that both be heard."

RE LEEDS ARC SYSTEM FOR MILLS.

SIR,—Doubtless many of your readers will, like myself, have eagerly perused the article and illustrations in your issue of the 14th inst. to see if it was anything in their way, or of any advantage, commercially or educationally, to themselves.

We are generally under deep obligation to gentlemen who place the result of their experiments before their *confrères* through a technical journal, yet when one sees what strikes him as a possible abuse of the apparatus or system described, he may perhaps be excused for rushing to pen and ink, leaving it to your discretion to put it into print or the editorial waste-paper basket. This is my excuse for this intrusion on your space.

What strikes me as the abuse referred to is the proposed introduction of the system described into mills and factories. Is it suitable for the majority of such? From my knowledge of Yorkshire and Lancashire textile mills and machine shops, I should say decidedly, no. Suppose we want 20 arc and about a dozen 16-c.p. incandescent lamps (not an outrageous demand), we must have at least 1,000 volts *within the mills*. In the mills I refer to, my experience leads me to believe that, owing to causes connected with the work carried on and often poor state of repair of the building itself, faults in insulation at the fittings, putting on an "earth" or "ground" are more likely than not to occur, probably within 12 months of erection of the installation. It would then be quite possible to get an available E.M.F. of 1,000 volts to give a shock to any unfortunate mill hand who might, perhaps, in the discharge of his duties touch another bare or insufficiently insulated part of the circuit. Such faults, of course, should not occur, but when we take into account the possibility of small slips in installing, the carelessness of workmen, and, worst of all, the all but irresistible pressure often brought to bear on a small contractor to take work at far too low a price, who can say we are safe? If faults occur with 100 volts, what may we not expect with ten or twenty times that voltage? In central station plants we can have frequent if not constant testing. In private installations, who would pay for it? Altogether it seems to me we should, in bringing high tension into buildings where experienced electricians are not always in attendance, be courting a repetition of the accidents we heard of not so very long ago (principally from the other side of the herring pond) which we all so much deplore. Is it wisdom to run this risk to save a hundredweight or so of copper? which, by the way, need not be nearly so extensively insulated with a low-tension system as a high; and your statement in this head appears to me much exaggerated, save for exceptional cases, so far as applying to mills and factories.—Yours, etc.,

A. W. BENNETT.

CARLOW.

SIR,—I fear your references to Carlow, as quoted from the catalogue of Messrs. J. E. H. Gordon and Co., have been dictated more by zeal than exactness.

You say the TOTAL revenue of the gas company amounted to about £1,700, of which the electrical works have secured £400 during the first four months. Having the balance-sheet of the gas company for the year ended March 5, 1892, before me, I find—

Gas rental amounts to ..	£1,560
Meter " "	58
Residuals	316
Sundries	70
	£2,004

which would not bear out your remarks.—Yours, etc.,

Cork, Oct. 16, 1892. JUSTITIA.

[It should have been "total revenue from *rentals*."—ED. *E. E.*]

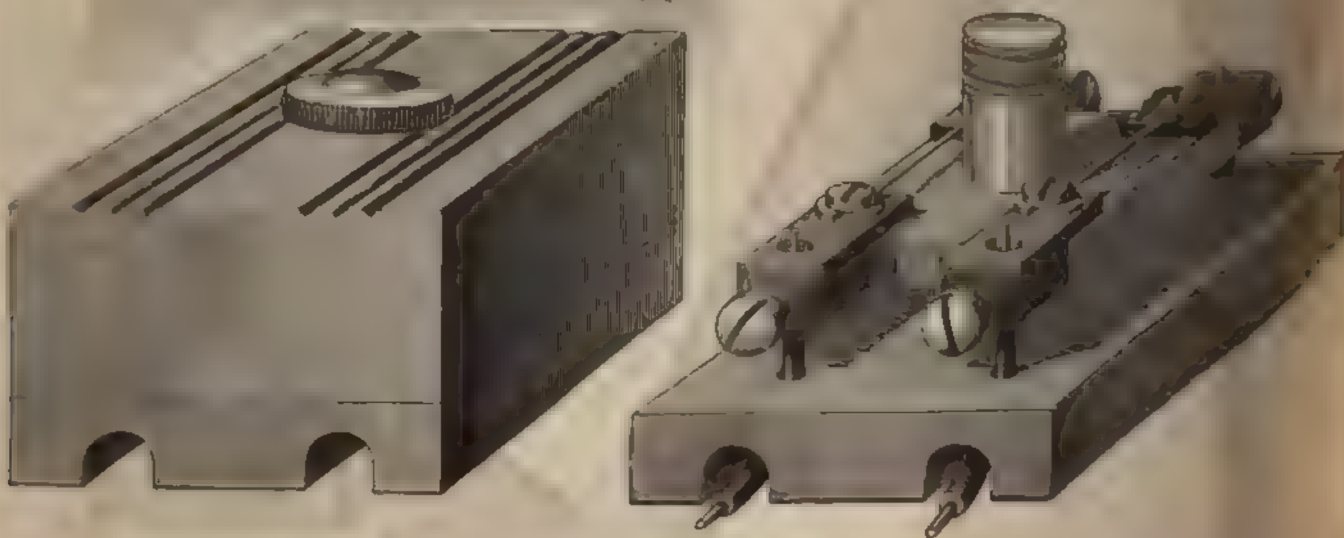
VERITY'S COMPENDIUM.

Ornamental Branch Switch.

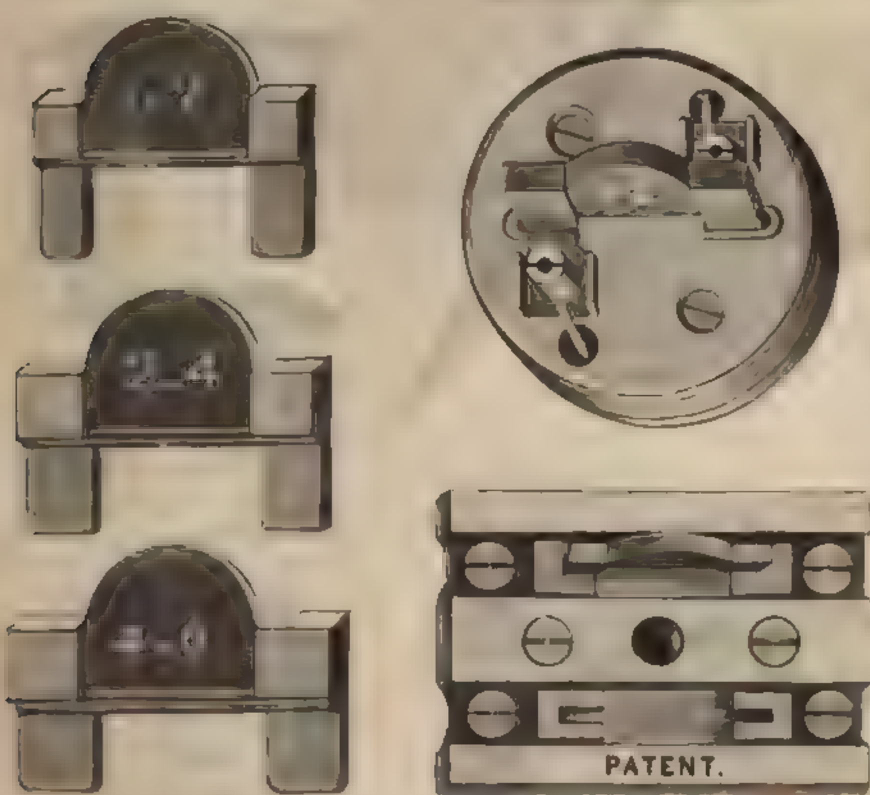
Ornamental Branch Switch.

Ornamental Branch Switch.

Single Fuse.



Aston Perfection Insulation Fuses.



Patent Safety Fuses.

Aston Ceiling Rose.

One of the front rank firms in their own special department electrical fittings—is that of Messrs. B. Verity and *Sons*. This firm, established many years ago, was at one time split into Verity and Sons and Verity Bros., but competition under the same name not suiting either party the success of the amalgamation which was carried out has

long since proved the wisdom of that step. Business has grown with the extension of electrical engineering, and the firm, besides their original offices, showrooms, and factory at 31 and 32, King-street, Covent Garden, have now the West-end showrooms at 137, Regent street, a wholesale showroom at Heddon-street, Regent-street, and large manufacturing works recently established, and now in full swing, in Birmingham, known as the Plume Works, Aston.

Messrs. Verity have recently placed upon the market, at the price of 7s. 6d., what they term a "Compendium," likely to be of use to all electrical contractors. This must not be mistaken for a new fitting, a complex switch, or coupled set of dynamos or engine—or, in fact, the trade name for any new article. It is their distinctive name for a catalogue, and the full title is "Verity's Compendium of Electrical Appliances." Having become known more particularly as the designers and manufacturers of high-class ornamental fittings, brackets, electroliers, and so forth—as, indeed, their telegraphic address, "Electrolier," would serve to show—it might be thought that this catalogue contained a full and complete illustrated list of these handsome articles for the fitting of mansions. But no; this is to come. A sumptuous and delightful catalogue of Verity's art fittings is promised, and is, we believe, in the press. But at present we have to deal with the mechanical and useful electrical appliances—from boilers and engines to sockets and bell knobs; nay, even medical electrical appliances find a full place therein. Besides being large manufacturers, Messrs. Verity are factors—merchants and shippers—of every conceivable kind of electrical plant and fitting, and apparently wish so to be known. For the "Compendium" is not only a list of their own manufactures—though in this article we shall give most attention to this part—but it contains a full and classified illustrated description of the better known forms of electrical plant of all kinds, and, by their large connection, the firm have special facilities for this class of business at manufacturer's prices. For those who wish to possess this extended outlook we will describe the contents and then pass to the illustration of some of the newer fittings.

Patent water-tube boilers of the type of which over 800,000 h.p. are now in use, occupy the first page; full information is appended as to their construction, economy, and ease of transport, a special type being supplied for colonial use, where facility of transport is desirable and the cost of freight is high. The ordinary Cornish and Lancashire boilers of good make are shown. Engines of a high class make—compound horizontal semi-portable, vertical with boiler, and others—are shown, as well as high speed of Willans's and Armington Sims's make. Worthington pumps for feed-water comes next, and "Household's" patent water-lifter or steam jet pump for raising water with either low or high pressure steam. Oil engines and the "steam turbine" dynamo occupy a page apiece, and then we come to "Victor" turbines in many forms, specially suitable for dynamo driving. Snow's waterwheel governor is used with these. Dynamos naturally occupy a large space, and the following types are shown and recommended: Victoria, Manchester, Elwell-Parker, Castle, Phœnix, Goolden, Oldham, and Tyne machines. Combined self-contained portable plants receive attention, and a very full set of the various applications of electric motors is shown; we have electric draining pumps for mines, rotary coal or rock drills, gear-driven continuous-rope hauling engines, mining motors, electric ventilators, electric triplex pumps, electric launches, with a special department for electric traction, showing the Bournbrook system of trams. Accumulators of the well-known type are fully illustrated, with fittings, charging switches, cut-outs, and so forth, and portable batteries and hand lamps, which are now beginning to be very widely used, are illustrated in the most useful forms. After arc lamps, incandescent lamps, instruments, and switchboards, we come to some interesting types of special fittings, many of them quite new, some of which we illustrate herewith.

Nothing better or simpler for large low tension currents can be used than the well known "knife" switch, which Messrs. Verity make in large sizes, ranging from 150 to 1,000 amperes. They are strong, and have no parts to get out of order. They have large surfaces, cleared at every contact, and the current passes through no joints. They are to be recommended for main switchboards in station work, and are made for double-pole break, and also for changing over from an ordinary to a three-wire circuit. A main switch much in use for smaller circuits and private installations is Verity's patent main switch, with automatic quick-break action. They are fitted in cast-iron frame, with slate or china centre, double-pole break, with china cover. They are made usually in sizes from 20 to 50 amperes.

Considerable attention has been given to richly-decorated switches for branch and lamp circuits in houses. First-class designers have been set to work to produce switch covers of an artistic kind in Italian, Renaissance, Elizabethan, or other decorative style to suit the surroundings. These switches are made in three different actions—side lever, tumbler, and ordinary twistle handle shape. They are made in silvered, gilt, black, or cream china, and being fitted with ivory handles, make very suitable switches for high-class mansion installations. They are made to carry three, five, or ten amperes.

An interesting novelty for fitting in dark corners or in bedrooms is the luminous switch (Towle and Langdon's patent). These switches are provided with an application of luminous paint, so that they become visible in the dark. They are particularly applicable for switches in hotels (and the spare rooms in private houses), where the rooms are frequently used by strangers, who may otherwise be obliged to fumble about for a long time, and, perhaps, bark their shins over the furniture from not knowing the exact situation of the lamp switch. An ordinary switch can be mounted on a luminous base, which is supplied separately if desired.

We now come to the question of safety fuses. Here Messrs. Verity excel, for they offer some types of cut-outs of an exceedingly useful and well-organised description. The desiderata in a cut-out are that it should be fireproof, easily fixed, the fuse should be easily replaced, and that it should be impossible for a fuse of a larger conducting power than that desired to be inserted in the fuse box. In Messrs. Verity's double safety fuses we have these requirements carried out in a simple manner, which can easily be seen in the illustration. The fuse-box—either single or double-pole, as desired—is made with metal contact tubes, into which a fuse-plug can be inserted by the pressure of the finger and thumb. The fuses are marked with conspicuous figures to indicate the current they carry, thus: 1-2, 2-4, 4-6, and so on. These fuse-slips are each made to a certain length and thickness, those carrying the higher currents being the largest. The slots in the fuse-boxes are made to fit one size only, and it is absolutely impossible to insert a large fuse into a block intended for a small circuit. It is thus impossible, either by design or inadvertence, to use the wrong size of fuse, except by actually unscrewing the box and fixing another. The fuses are placed in position easily after the house is wired without tightening or loosening any connections. They deserve to be very widely used and specified.

Theatre fittings have received considerable attention on the part of this firm, who have fitted up several of the large London theatres. They make a number of special fittings, consisting of large shoes and plugs let in flush, or for hand insertion. A shoe and plug, with handle, is largely used for stage work where temporary connections for a large number of lights is necessary, the stock size being for 50 amperes.

One of the first necessaries in installation work is insulated wire, and these are dealt with in a detailed manner. The directions given in the "Compendium" for jointing may be worth quoting for those who wish to do their own jointing: "First strip the insulation back for a few inches to allow sufficient space for soldering without injury to the indiarubber. Then solder. In stranded wires it is advisable to wrap the strands with a spiral of tinned copper wire. At any rate avoid all sharp points, and do not allow ends of wires to stick out, or they may pierce the pure indiarubber. After soldering (without acid), cut back the insulation of cable or wire to a taper form. Rub a very little rubber solution on the wire itself and the

tapered ends of the original rubber insulation; then wrap with pure rubber strip from one end to the other and back, so as to give at least three layers of pure rubber. Be careful not to use too much solution (more than above mentioned is liable to work injury), and in tapping the pure rubber a continuous and heavy strain should be kept up, causing a small film of solution to ooze through between the lappings. This is quite sufficient to render the three layers of strip adhesive, and, ultimately, homogeneous. The strip should be thoroughly over-lapped on itself. After thorough lapping with pure rubber, two or more lappings of double-proofed tape should be wound on in a similar manner as tightly as possible. The last end should be fastened by a slight application of solution. The following are the four important rules in jointing: (1) Avoid acid in soldering; use resin. (2) Do not use too much solution. (3) Lap the rubber strip as tightly as possible (4) Cleanliness is of the utmost importance. Where possible the work should be divided so that one operator does the cutting away, another the soldering, a third the pure rubber lapping, and so forth. It is certain that a man with his hands smeared with solution cannot make a clean joint."

Perhaps one of the minor points in electrical practice that has received the largest share of the attention of inventors is that of the construction of ceiling roses. The rush is now, and rightly, for what has become known as "high insulation" types of china fittings. Messrs. Verity have a ceiling rose of their own type which has many points to recommend it. They are made of porcelain, the base having a double plate, one being used for fixing to the ceiling and the other for electrical contacts. They thus avoid possibility of leakage to earth from the terminals, as none of the terminals pass through the base. The china or brass cover is placed over and fixed down by a nut screwing on the top of the china pillar. A number of lamp fittings and their parts are shown, so that contractors may make up their own pendants if desired. A very useful fitting is the patent swing joint for electroliers and combination gas and electric pendants. It is easy to fix—the wires are hidden and the pendant always hangs vertical A fitting that is very widely used is the silvered reflector to clip round a 16 c.p. lamp. Another fitting, very useful in hotel and club lavatories, is an automatic door catch which lights the lamp when the door is closed.

A large number of very tasteful globes, glass and silk shades are shown. These being well known, need no illustration. But a fitting more novel, and, we should think, very useful, is the plate-glass convex reflectors, Timmis's patent. An ordinary lily or floral shade is carefully moulded to give a certain required angle of reflection, and the inner surface is silvered. The consequence is that lamps with which these reflectors are used give some 30 per cent. more downward light. They are very suitable for office and library use.

Amongst the numerous smaller appliances described and illustrated, there are comprised nearly everything that a householder or contractor can require electrically. Small sets of dynamos and lamps, for five to 20 lamps, are largely used abroad for tea sorting, and in works and offices Linesmen's tools are largely illustrated, wire-drawers, soldering furnaces, tools for cutting lead covering of cables, and so forth. The patent insulating material known as cellulvert was first introduced in this country by Messrs. Verity, and is highly recommended by them. Telegraph instruments are now made in large quantities, many of the large railway companies being their customers. Bells of all kinds and telephone sets receive necessary description, and the "Compendium" ends by a very wide assortment of electrical medical apparatus of special manufacture, English and foreign, for which the firm are now agents. An exhaustive index completes this very carefully-compiled catalogue, and amply illustrates the very wide field over which electricity now ramifies.

Theory of Accumulators.—M. Bidard, professor of chemistry at Rouen, has brought forward a new theory of accumulators, publication of which is promised shortly.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.*

BY PROF. GEORGE FORBES.

LECTURE III.

(Concluded from page 386.)

The lines of force, in cutting through the wire of the armature, induce electric currents in the wire, of course; and since the armature opposes the creation of these induced currents in the wire, a natural mechanical opposition is offered to these wires being cut by these magnetic lines of force; and the consequence is, the armature is carried bodily round, and tries to turn round at the same rate at which the magnetic field is travelling round, in which case the conductors would not be cut at all by the lines of force That is the general principle of the machine, which was independently invented by Ferraris, of Turin, and Mr Tesla. The results of the official experiments which were made at Frankfort have not yet been published, and consequently we are hardly in a position to speak of the value of them; but I may say that we have not the slightest doubt that this system of multiphase transmission is an extremely effective mode of transmitting power, and that it opens a new field, and is equally suitable for distribution and for transmission, and in that way has an enormous advantage over the simple alternating-current system with synchronising motors. It has all the advantages of simple alternating currents, in that we can use low-tension dynamos, which are perfectly safe things to deal with, and which can be made of thoroughly mechanical construction; we can increase the pressure by means of a transformer, and carry the power to a distant station; lower the pressure there to such a pressure as is convenient for distributing through a town, and then take it off at the houses where the motive power is required, and drive our motors. That is to say, it has all the elasticity of the ordinary alternating-current system; and its motor has the enormous advantage over the synchronising motor in that it is a machine which is suitable for placing in workshops—one which you can start and stop as often as you please.

One of the greatest uses of electrical motors in workshops with which I am acquainted is their use for cranes, especially travelling cranes. There are many other cases where it is highly useful for replacing shafting and for the working of machinery. In all these cases we need to be continually starting and stopping the motor. We cannot leave the motor continually running; and it is essential for these purposes to have some motor like this rotating-phase motor, in which we can start frequently and effectively. We have had no tests published of the Frankfort trials as to the power of starting, but I may perhaps interest you by giving you, in concluding this lecture, a few results of experiments which I made this afternoon with such a rotating-phase motor, as I do not think that any results have been published at all. I will only just give you one or two results. I will give you one just to show you what work the machine was doing. It was not doing a very great deal, but I will give you an example of what it was doing. The alternating generator was driven by means of a continuous-current motor, the current being supplied to it from the mains of the Westminster Supply Company. That alternating generator supplied alternating currents to one of these rotating-phase motors. That motor in turn was caused to drive a continuous-current dynamo machine, and it supplied a number of lamps. We were able to measure the volts and amperes which came in from the Westminster Company, and the volts and amperes which went to the lamps, and we could get an idea of the amount of work which was being done by this motor.

With the first continuous-current motor we had 102 volts in one experiment and 39 amperes. And on the lamp circuit where the work was being done we had 89 volts and 9½ amperes. That shows that we were getting something over a horse-power from the motor. That is the only reason that I put down these figures. You must not take these figures as representing the efficiency

* Cantor Lectures delivered before the Society of Arts.

of the alternating motor in the least degree. They give us no information on this, because, in the first place, it was an inefficient motor which we were using to drive the alternator, and it was an extremely inefficient dynamo which we were using to generate the current for the lamps, so that we had really no test of efficiency whatever. But it gives you an idea of the horse power which we were using. The motor was a motor which was giving us off about 1 h.p. in the lamps, but it was working up to a higher figure. Now an interesting experiment was to find what power there was at starting, and I found that on a pulley having a diameter of about 5in., there was a pull of about 40lb., when the alternating motor was supplied with current at the same pressure as in the previous experiments; that is to say, in the ordinary working of that alternating motor as at that time, we would get a pull of about 40lb on a pulley of 5in. The speed at which we were going in this experiment was 1,380. Now the pull at 40lb which I found on the pulley would have given us 2 h.p. at that speed. Consequently the torque at starting was extremely good; and although this is a very rough experiment, it is of the greatest interest to myself to have the measurement of the starting torque with such a motor, because I have not been able to get any other actual measurements of any sort whatever. We shall get more accurate experiments very soon no doubt, but this is the first step in the right direction.

Lecture IV.

In my last lecture I was dealing principally with the question of using water power in connection with electric lighting and electric power. There are two engineering problems, important to engineers, in connection with the use of water power; one is, where we are using it simply for lighting up a very small place, and one frequently has to deal simply with the lighting up of a single country house.

The extreme case, on the other hand, is the transmission of power to great distances, where you want to utilise a waterfall, and bring the power into a town and use it there for motive power or for lighting. These are two very distinct problems, and there are several points in each of them that need particular attention. It may be worth while to introduce a word of caution in connection with the use of water power for lighting country houses. I have found from experience that the very greatest caution is necessary in utilising water power that may seem to be perfectly available. In the first place, it is generally extremely difficult to find out what is the exact amount of power which can be obtained from the source of the supply. Of course, the water power in this country is generally superabundant in winter, and diminishes in summer. That is a fortunate thing for us, and suits the demand for light; but it becomes extremely doubtful whether the supply of water which we can get in the very driest time of a dry summer will be sufficient for our purposes. I may say that, whenever it appears, from observations that you may take at any one time, that there is the slightest doubt it is the most injudicious thing to set up turbines and plant for utilising the water power without having taken measurements of the flow of water, at least during one summer, and thus judged as to the probability of the supply during a particularly dry summer. But there is another equally likely catastrophe to happen, which is far more serious and important, and that is that in a great many places, where it appears perfectly certain that we shall have enough water during the whole of a dry summer, there may come on a heavy frost in the winter, which will freeze up the source of a stream, and prevent us from getting our power in mid winter. The fatal effect of such a thing is evident, because it is in mid winter that we want our light most; but it sometimes happens that a small burn that we intend to use for electric lighting, which the inhabitants around may tell you certainly never freezes, and that the flow in winter is always superabundant, may sometimes be found to freeze, and you are deprived of water power in the very middle of the winter. In such cases, however, it very frequently happens that it really *would* be a saving of expense to introduce turbines, besides having an auxiliary boiler and steam engine for cases of emergency. It is a large additional expense to the original plant, but it is in most cases extremely useful and very economical, when we consider the saving that the water gives us in the consumption of coal during the greater part of the year.

But there is another point of economy which sometimes has not enough attention paid to it, and that is when the source of water power is not exactly on the premises or where you want the power to be used. It very often happens—in a country house, for instance—that the power is at a distance of, say, half a mile from the house. Now, even the distance of half a mile is serious, when you come to calculate the size of the conductors which will be required to convey your current from the source of power to the house. Too often people have gone upon the assumption that the cables would not have to be very large, and have been disappointed in this way, and have thus been led to very considerable expense.

With regard to the extreme case of using water power for transmission to a distance and, it may be, subsequent distribution through a town, I spoke pretty clearly on the last occasion; and while at the present moment most cases of transmission would be best done by means of the alternating current, I can quite see cases where the continuous current is the most applicable, and there is no reason why we should not transmit our 10,000 volts or so by means of a continuous current for such purposes, only taking far greater care for matters of safety, because the dangers of a machine with a commutator are very much greater than with an alternating-current machine. Of the means available for using the alternating current, as I have stated, there are two which may be considered, at the present moment, as decidedly the best. The one is by means of synchronising generators and motors, which are ordinarily alternating-current dynamos, working synchronously with each other; and the other is by means of the rotary phase system of transmission. I pointed out, at the end of the last lecture, that, while light alternators will not work well as motors when they are used singly, with a simple pair of conducting wires, you may use them in pairs, receiving two different currents in different phases from a similar pair acting as generators, one receiving its maximum when the other is receiving its minimum; that that arrangement enables us to get over the dead centres; and that such a machine, if it is extremely light, will start with a good pull from the beginning, and will do transmission work extremely well. Thus it appears that two Ferranti dynamos arranged in that way will make a generator of two currents, and will work as a motor also, and will work well, and will start well as a motor; whereas the Mordey alternator, which I contrasted with it in the ordinary way of working, has a very massive rotating part, and in consequence of that, it will not start as a motor as well as a light machine, when we are using two separate currents. Thus we have the curious fact that the heavy Mordey machine is the better as a synchronising alternator of the two, whereas the light Ferranti alternator is the better one, where you are using two currents in different phases.

Lately, in America, the dynamos which had been used for generating continuous currents for tramways by the Westinghouse Company have been fitted with rings for use instead of the commutator; four rings for taking off two alternating currents, one giving its maximum when the other current is giving its minimum. These large powerful machines have been working admirably as motors; they start very readily indeed, and, of course, continuous currents can be then taken off, on the same sort of principle as was shown by Mr Schuckert at the Frankfort Exhibition, which has been talked of a good deal since. That machine has been very largely adopted indeed, and has been doing admirable work.

Coming now to treat of another matter in connection with water power, I wish to draw attention to what has been done in Switzerland in the way of utilising water power. Last summer I had the advantage of travelling with Prof. Unwin through Switzerland, our object being to study the various cases where the natural power of water had been utilised for transmission to a distance,

pelled to increase the accommodation for that staff, as there were no houses at St. Vincent. They had also to erect tanks for their spare cable, and to extend their office accommodation, at a cost for the half year of £1,150. Then there was the cost of applying duplex to No. 2 cable, £3,000 of that cost falling due in the half year under review; but that would now be reduced to £500 for each half year for the next six years. He might inform them that the duplex had been of immense value to their working. Working both ways was a great benefit, and they could, when they think proper, work both ways on the next cable also. That brought the total decrease of expenditure to £2,929. With their permission, he would not refer to all the items of increases and decreases in the balance sheet. He would now refer to such criticisms as had come to hand from three of their proprietors. Out of 2,900 shareholders they had had three letters. Naturally they received such criticisms with all respect, and they considered among themselves whether their policy could be defended upon business principles in the best interests of the proprietors, the efficient maintenance of the property and the security, so far as it was possible, of their revenue for the purposes of dividends. For several years he had warned them that something like a crisis was coming, and now, at that moment, they were face to face with a rivalry which would test the wisdom of the policy of that Board since the formation of the Company 19 years ago. One honourable proprietor was of opinion that they ought not to make extensions out of revenue, but add all to capital, and that all such expenditure as could be properly debited to capital account should be so treated. Of course, as a matter of bookkeeping, there was much to be said in support of such a contention; but, if such a policy were adopted in practice, then farewell to quarterly dividends, and when, in the course of time, a large expenditure of capital became imperative, it could only be got upon such onerous terms as would postpone or destroy all prospect of any dividends upon ordinary stock, whereas, with a large reserve, such as they now had, and with a moderate amount of debentures, they could at once lay another cable if they desired to do so. They were in this position: their revenue-earning capacity was secure, even though a tariff war should be forced upon them. They would not willingly initiate it, but they were directly threatened with it, both on the west and on the east coasts. A reduced tariff, however, would, no doubt, increase the traffic, and besides being in a position to carry it better than any other company, if the fight were too hard they had the interest of their reserve to fall back upon for dividend purposes, if need be, as supplementary to their income from traffic. They were not exactly on their backs, if they had a great opposition, for they have that reserve of interest to fall back on, and they would not had to go without a dividend, even though they dipped into the reserve. They were not so weak, therefore, as their opponents thought—at least he believed not. The Directors had always followed the principle of keeping the capital down, satisfied if they could pay a fair dividend and keep a strong reserve. The other honourable proprietors who had written to the Board were of opinion that they ought to pay a larger bonus, and they said what they were very conscious of, that the sum carried to reserve is large in proportion to the dividend. That was very true; but they had a property liable to attack, and which was being attacked at the present moment, and in a manner which seemed to leave no alternative short of a war of tariffs. It looked like that at the present moment, but a great deal might happen between just now and by and by. They were warned by their rival on the west coast that if they did something—which this Company certainly would do, and must do—they would reduce the rates; but they were not without resources to meet that threat, if it were to be put into practice. That rival, so far, lowered the tariff, and so had they. On a previous occasion he told them they had reduced their tariff by 33 per cent. and 50 per cent., and they could go as low as any company could, and not be altogether without a dividend. He thought he told them at their last meeting who their rival was. He had a cable from Panama to Valparaiso. A few years ago their Company worked in harmony with a company called the West Coast of America Company, going from Lima and Callao to Iquique, Arica, and those ports down to Valparaiso. For some reason not known to them yet, that gentleman disregarded his partners, and carried his cable down to Valparaiso, leaving the west coast cable out in the cold. It so happened that the Globe Company was largely interested in that cable, and they did not see—and do not yet see—why that cable should be ruined, and they did not intend that it should be. In order to protect that cable a company had been formed to lay a land line across the Andes from Valparaiso to connect the west coast of America cable with the east coast cables, so they would have in a few months' time cable communication all the way from London to Lima from Peru to England and Europe; and their friend threatened them, as he understood, that if they did not let it alone he would do something very dreadful, and come and attack them, as he had done for years. They were making that line, however, across the Andes. It was three parts made already, and, do what he would, they would fight for it, and they would then see what happened. Then there was the company on the east coast from Senegambia to Pernambuco. That cable had been making for the last two years, and now opened, or about to be opened, for traffic. The promoters sought to raise money by the avowed and published statement that they would take £80,000 per annum from that company or the joint purse companies, and they opened their cable at a tariff 6d. per word lower than the tariff agreed upon—as fixed on by the Paris Conference as the obligatory tariff by every route for extra European traffic. He would explain that. The Telegraph Convention, which met every five years, had agreed that all traffics transiting any part of Europe was certain traffic, and that no company should come in and have a lower tariff, the object of the convention being to create as many ways as possible for telegraphic communication at equal rates—not opposition rates. That was called the European *régime*. For extra European traffic there was a higher tariff charged over the land lines transiting Europe, because they very properly said, "If we have to maintain land lines all through Europe, Russia, Italy, and those great distances—if we have to maintain them for extra European traffic—necessarily, as there is nothing else going over those lines, we must have a larger tariff." There was, therefore, a European *régime* and an extra European *régime*, and the convention said that those two tariffs should be common to all comers; but no one was to come in and oppose them with European powers by some accidental line got up for [illegible] purposes. Therefore they were leagued together at this conference to establish a tariff fair to all comers. It seemed strange to [illegible] that a private company, in disregard of inflicting loss upon every European State, and upon the cable companies more especially, should, without any attempt to negotiate, rush before the public with a reduced tariff, for no reason in the world but to force them to make terms that would give a value to their property which it did not now possess, as it is, so to say, a fifth wheel to a coach. Now he did not wish to say even so much about the case, but it was due to them that he should say something about a rival that had just come into the field. Its promoters, who are also its proprietors, were not allowed to carry their traffic lower than the convention rates; but they were, he was told, carrying Press traffic free—or they were doing so two days ago. They were, as they said, determined to worry them into terms which they hoped would enhance the value of their speculative cable. They pretended friendliness, and, personally, they were all friends; but they left no stone unturned to injure them, and it was possible they might tire of carrying even Press messages for nothing. At all events, it did not frighten them. Then there was the Antilles cable, which was owned by a French company, and which went from Guadeloupe down to Para. They hoped to get a concession from Portugal to go to the Azores. That was given to their Company, but from some [illegible] diplomatic action it was taken from them. As he had said, that French company were now trying to obtain from France a subsidy of £80,000, and if they could get that they proposed to carry the [illegible] and join it on to the Antilles cable. He did not know that [illegible] was very much inclined to pay that £80,000, and, at all events, they had not got it yet. They would observe from what he had said that it was a very costly fight that was now going on, but he ventured to believe that they would approve their policy of paying a moderate dividend and making a strong reserve, equal to a system of offence or defence. They were carrying messages from Buenos Ayres to England within the hour, and from Pernambuco to Rio Janeiro within the half hour. Commerce would not want greater facilities than that, unless it were that they should [illegible] telegrams free, and that they could not do. They were just now in a position as if a merchant in London had his foreign correspondent in the same building, and they carried on their intercommunication by what some [illegible] called a whispering gallery. There was no system of international telegraphy which could beat them. He did not know what science had in store for them; but, so far, they did not know that there was anything looming in the distance that could excel what they were now doing, and they could adopt anything that may be proved to be better and faster. Their cables were duplicating and duplexed, their speed of transmission could not be excelled, and they had a substantial reserve, which enabled them to look their rivals in the face, and they certainly need not be under any feeling of panic or alarm. That was the position they were in and, in his opinion, it was a sound one. They had laboured at it all along for 19 years steadily pursuing the policy of building up a reserve fund, and warning them from time to time that this was their backbone, and that while they were paying a good dividend they must be satisfied to let the Directors take from the revenue what they could spare to strengthen their position. The Chairman, in conclusion, said: "I look forward to this with our reserve fund, that if we were in a tight fight we could do two things—we could take the interest on the reserve fund and [illegible] to the reserve, and not add any more to that fund, or we could take it for increasing your dividend, plus any dividend arising from the traffic. I, therefore, do not address you in a [illegible] spirit or in a despairing tone. I think we are in a good [illegible] position. If any shareholder desires to ask any question, I will do my best to answer him; meantime I propose the adoption of the report and accounts, and the payment of the dividend and bonus recommended."

Mr Frederick Youle seconded the motion.

Dr Trowbelle, whilst supporting the Board in setting aside a good reserve fund, thought the Directors might take into consideration whether the amount transferred to that fund might be £10,000 or £20,000 a year less.

The **Chairman**, in reply, urged the proprietors not to press the Board on that subject at the present juncture, and pointed out that they were as much alive to the importance of the question raised as the shareholders.

The motion was then put and carried unanimously.

On the motion of the **Chairman**, Sir Henry Tyler, Bart., and the Duke de Loule, retiring directors, were re-elected.

The **Rev. N. Willis** proposed the reappointment of **Mr Henry Dever** and Mr. John Gane as auditors of the Company.

This was seconded by **Mr W. C. West** and carried.

The meeting closed with the usual vote of thanks to the Chairman and Directors, proposed by **Mr Griffiths** and seconded by **Dr. Trowbelle**, which was briefly acknowledged by the **Chairman**.

BOARD OF TRADE REPORT.

The following is a continuation of the appendix to the Board of Trade report as given in our last issue.—Ed. *E.E.*

PROVISIONAL ORDERS.

Title of Order.	To whom granted.	Revoked or repealed.
	1890.	
Metropolitan Electric Supply Co. (Paddington) Lighting Order, 1890.	Metropolitan Electric Supply Co., Ld.	—
North London Electric Supply Order, 1890.	House-to-House Electric Light Supply Co., Ld.	Revoked July 10 1891.
St. James's Electric Lighting Order, 1890.	St. James's and Pall Mall Electric Light Co., Ld.	—
Wandsworth District Electric Supply Order, 1890.	House-to-House Electric Light Supply Co., Ld.	Revoked Jan. 21, 1892.
Malvern Electric Lighting Order, 1890.	The Local Board.	—
Manchester Electric Lighting Order, 1890.	The Corporation.	—
Morecambe Electric Light and Power Order, 1890.	Messrs. Thomas Reginald Andrews and Thomas Preece.	—
Moss Side and Stretford Electric Lighting Order, 1890.	Manchester House-to-House Electricity Co., Ld.	—
Northampton Electric Lighting Order, 1890.	Northampton Electric Light and Power Co., Ld.	—
Nottingham Electric Lighting Order, 1890.	The Corporation.	—
Oldham Electric Lighting Order, 1890.	Do.	—
Oxford Electric Lighting Order, 1890.	Electric Installation and Maintenance Co., Ld	—
Plymouth Electric Lighting Order, 1890.	Devon and Cornwall Electricity Supply Co, Ld.	Revoked Nov. 24, 1891.
Portsmouth Electric Lighting Order, 1890.	The Corporation.	—
Preston Electric Lighting Order, 1890.	National Electric Supply Co., Ld.	Repealed by Preston Electric Lighting Order, 1891.
Preston and Fulwood Electric Lighting Order, 1890.	Lancashire and Cheshire House-to-House Electricity Co., Ld.	Revoked June 10, 1891.
Salford Electric Lighting Order, 1890	The Corporation.	—
Sevenoaks Electric Lighting Order, 1890.	The Electric Trust, Ld.	Revoked June 18, 1892.
Stafford Electric Lighting Order, 1890.	The Corporation.	—
Stockton-on-Tees Electric Lighting Order, 1890.	Do.	—
Tiverton Electric Lighting Order, 1890.	Do.	—
Tunstall Electric Lighting Order, 1890.	The Electric Trust, Ld.	Revoked June 18, 1892.
Walsall Electric Lighting Order, 1890.	The Corporation.	—
Wigan Electric Lighting Order, 1890.	Do.	—
Windsor Electric Supply Order, 1890.	Windsor and Eaton Electric Light Co., Ld.	—
Woking Electric Supply Company Order, 1890.	Woking Electric Supply Co., Ld.	—
Wolverhampton Electric Lighting Order, 1890.	The Corporation.	—
Worcester Electric Lighting Order, 1890.	Do.	—
Wrexham Electric Light and Power Order, 1890.	Wrexham and District Electric Supply Co., Ld.	—
York Electric Lighting Order, 1890.	The Corporation.	—
	1891.	
Acton Electric Lighting Order, 1891.	The Local Board.	—
Birmingham Electric Light and Power Order, 1891.	Birmingham Electric Supply Co., Ld.	—
Bishop's Stortford Electric Lighting Order, 1891.	Bishop's Stortford Electric Light and Steam Laundry Co., Ld.	—
Bolton Electric Lighting Order, 1891.	The Corporation.	—
Bromley (Kent) Electric Lighting Order, 1891.	The Local Board.	—
Canterbury Electric Lighting Order, 1891.	The Corporation.	—
Cardiff Electric Lighting Order, 1891.	Do.	—
Chiswick Electric Lighting Order, 1891.	The Local Board.	—
Coventry Electric Lighting Order, 1891.	The Corporation.	—
Croydon Corporation Electric Lighting Order, 1891.	Do.	—
Dewsbury Electric Lighting Order, 1891.	Do.	—
Ealing Electric Lighting Order, 1891.	The Local Board.	—
Edinburgh Corporation Electric Lighting Order, 1891.	The Corporation.	—
Exeter Electric Lighting Order, 1891.	Exeter Electric Light Co., Ld.	—
Hanley Electric Lighting Order, 1891.	The Corporation.	—
Harrogate Electric Lighting Order, 1891.	Do.	
Heckmondwike Electric Lighting Order, 1891.	The Local Board.	—
Hertford Electric Lighting Order, 1891.	The Corporation.	—
Ipswich Borough Electric Lighting Order, 1891.	Ipswich Electricity Supply Co., Ld.	—
Ipswich Electric Lighting Order, 1891.	Laurence, Scott, and Co., Ld.	Revoked Dec. 30, 1891.
Kidderminster Electric Lighting Order, 1891.	The Corporation.	—
Killarney Electric Lighting Order, 1891.	Charles Edward Leahy.	—
Kingston-upon-Thames Electric Lighting Order, 1891.	The Corporation.	—
Leeds Electric Supply Order, 1891.	Yorkshire House-to-House Electricity Co., Ld.	—
Liverpool Electric Lighting Order, 1891.	Liverpool Electric Supply Co., Ld.	—
Llanelly Electric Lighting Order, 1891.	The Local Board.	—
Camberwell Electric Lighting Order, 1891.	Camberwell and Islington Electric Light and Power Supply, Ld.	—
City of London Electric Lighting (Brush) Order, 1891.	Brush Electrical Engineering Co., Ld.	—
Clerkenwell Electric Lighting Order, 1891.	Do.	*
Islington Electric Lighting Order, 1891.	Camberwell and Islington Electric Light and Power Supply, Ld.	—
St. Luke, Chelsea, Electric Lighting Order, 1891.	New Cadogan and Belgrave Electric Supply Co., Ld.	—
St. Luke, Middlesex, Electric Lighting Order, 1891	Brush Electrical Engineering Co., Ld.	†
Southwark Electric Lighting Order, 1891.	Do.	—
Wandsworth District Electric Lighting Order, 1891.	Stamford Hill, Tottenham, and Edmonton Electric Light and Power Supply, Ld.	—

* The County of London (North) Electric Lighting Order, 1892, scheduled to the Electric Lighting Orders Confirmation (No. 5) Bill, now before Parliament, contains a provision for the repeal of this order.

† The County of London (North) Electric Lighting Order, 1892, scheduled to the Electric Lighting Orders Confirmation (No. 5) Bill, now before Parliament, contains a provision for the repeal of this order.

Title of Order.	To whom granted.	Revoked or repealed
Westminster Electric Lighting Order, 1891.	Westminster Electric Supply Corporation, Ld.	—
Woolwich Electric Lighting Order, 1891	Woolwich District Electric Light Co., Ld.	—
Londonderry Electric Lighting Order, 1891	The Corporation.	—
Newcastle upon Tyne Electric Lighting Order, 1891	Newcastle and District Electric Lighting Co., Ld.	—
Newport (Mon.) Electric Lighting Order, 1891.	The Corporation.	—
Norwich Electric Lighting Order, 1891	Norwich Electricity Co., Ld.	—
Paisley Electric Lighting Order, 1891.	The Corporation	—
Poole Electric Lighting Order, 1891	Brush Electrical Engineering Co., Ld.	—
Preston Electric Lighting Order, 1891.	National Electric Supply Co., Ld	—
Scarborough Corporation Electric Lighting Order, 1891	The Corporation.	—
Southend Electric Lighting Order, 1891	The Local Board.	—
Southport Electric Lighting Order, 1891	The Corporation	—
South Shields Electric Lighting Order, 1891.	Do.	—
Stockport Electric Lighting Order, 1891.	Do.	—
Sunderland Electric Lighting Order, 1891.	Do.	—
Surbiton Electric Lighting Order, 1891	The Local Board	—
Torquay Electric Lighting Order, 1891	Do.	—
Toxteth Park Electric Lighting Order, 1891.	Liverpool Electric Supply Co., Ld.	—
Tunbridge Wells Electric Lighting Order, 1891.	The Corporation.	—
Tynemouth Corporation Electric Lighting Order, 1891	Do.	—
Weston-super-Mare Electric Lighting Order, 1891	The Improvement Commissioners	—
Weybridge Electric Supply Order, 1891.	Weybridge Electric Supply Co., Ld.	—
Whitby Electric Lighting Order, 1891	The Local Board.	—
Whitehaven Electric Lighting Order, 1891	The Town and Harbour Trustees	—
Withington District Electric Supply Order, 1891.	Manchester House to House Electricity Co., Ld	Revoked May 13, 1892.

BUSINESS NOTES.

York.—The York tenders are to be sent in by November 21.

Belgium.—Tenders are invited for the lighting of the streets of Athus, a town in Belgium.

Boscombe.—The electric light was used for the first time in the Boscombe Arcade on Friday evening last.

Glasgow.—Messrs. R. Tullis and Co. have introduced the electric light into their works at Rothes Bleachfield.

Electric Railway at Havre.—A concession is in negotiation for an electric railway connecting Havre, Harfleur, and Montivilliers.

Electric Crane.—The electric crane for the Manchester central station is being designed and manufactured by Messrs. Mather and Platt.

Berlin.—The Berlin Electrical Works Company, which runs the large central stations in Berlin, has declared a dividend of 7½ per cent. for the last financial year.

Glasgow Cables.—The contract for the supply of arc light cables for the Glasgow Corporation has been placed with W. T. Henley's Telegraph Works Company, Limited.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino Brazilian Company, were £3,611.

West India and Panama Telegraph Company.—The receipts for the half month ended October 15 were £2,470, against £1,402. The June receipts, estimated at £4,825, realised £4,757.

Siemens and Halske.—The American Siemens and Halske Company have begun well with a contract for 17,000 lamps at the Chicago Auditorium, the largest private installation in the country.

Borough-road Polytechnic.—The full number of members—2,500—have already joined this polytechnic. Workshops for engineering and electrical work are to be eventually added at a cost of £4,000.

Wolverhampton.—At the last meeting of the Town Council, on the proposition of Alderman W. J. Jones, it was decided to purchase a quantity of land in Commercial-road as a site for an electrical generating station.

South Africa.—The Moodie's Company, says the *Financial News*, has commenced extensive operations in connection with the electrical transmission of power. Electricity, it is predicted, will do wonders for the mines in the district.

Southport.—At the final meeting of the Southport Town Council for the municipal year, Councillor Watson reported that the Electric Lighting Committee were making good progress, and that they would shortly be advertising for tenders.

Callender's Company.—The Directors of Callender's Bitumen, Telegraph, and Waterproof Company, Limited, have declared an interim dividend at the rate of 8 per cent. per annum on the capital of the Company, payable on November 1 next.

St. James's and Pall Mall Company.—The electric current sold by the St. James's and Pall Mall Electric Light Company, Limited, for the quarter ended September 30 amounted to £5,763, as against £5,279 for the corresponding period of last year.

City and South London Railway Company.—The receipts for the week ending October 16 were £90[illegible], against £794 for the same period last year, or an increase of £108. The total receipts for 1892 show an increase of £1,108 over those for the corresponding period of 1891.

Wolverhampton.—At the meeting of the Wolverhampton Town Council last week, the report of the Public Works Committee was adopted, recommending the purchase of land adjoining the canal in Commercial-road for an electric lighting station, and also the erection of a refuse destructor.

Cardiff.—At the meeting of the Cardiff Electrical Committee on Tuesday, plans prepared by Mr. Massey, electrical engineer to the Corporation, of the proposed new electrical works on the Canton Common, adjoining the Great Western Railway, were submitted to the committee and approved.

Aberystwith.—During the last 10 days a portion of the promenade at Aberystwith has been illuminated by two large arc lamps, an experiment by the Town Council, who are very likely to go in for a scheme for the complete lighting of the town by electricity. A provisional order was obtained by the Council some months ago.

Blackpool.—In our note last week on the proposed use of dynamos at Blackpool, it was stated that the same dynamos would be used for both tramways and arc lamps. This is obviously an error. What is intended is to work the tram lines and the [illegible] and private lighting from the same station, though not, of course, by the same dynamos.

Mill Lighting.—An interesting event took place on Tuesday night at the quiet village of Dunshalt, situated between Ladybank and Auchtermuchty. The one factory there, belonging to Messrs. Wilson and Hill, of Ladybank, was for the first time illuminated with electric light. For some time back the gas light has been both poor and expensive.

Fleetwood.—The time for receiving reports upon electric lighting for Fleetwood has been extended, at the request of two competing firms. When the reports are completed a special meeting of the Highway and Lighting Committee of the Fleetwood Commissioners will be called to consider them. The 22nd [illegible] the date named for completion of reports.

Belfast.—At a meeting of the Belfast Council in committee on Saturday a report was presented recommending an electric installation capable of supplying 10,000 incandescent lights, and for future extension if found desirable and that the services of an expert electrician should be obtained to advise as to the best system, and the best method of procedure.

Marseilles Cables.—The submarine cable from Marseilles to Oran has been laid, and has been working for over a month with satisfaction. The contract was entrusted to the Société [illegible] des Téléphones. The Tunis cable, of which the contract was given to M. Grammont, is not yet ready. The Oran cable is the first French cable carried out without foreign help.

Carnaby-street Station.—Our readers will be interested to learn that the St. James's and Pall Mall Company have [illegible] against their policy of exclusion of storage batteries, at any rate for their new station, and that a contract for the storage [illegible] has been secured by the Electrical Power Storage Company for the St. James's and Pall Mall Company's new station at Carnaby-street.

Cardiff.—At the last meeting of the Council, Mr. Lewis moved that the site set apart on the Canton Common for the electric light station should be appropriated for a cattle market. Mr. T. J. Bevan said he would do all that he could to stop either the electric light station or market being placed there, but after discussion, on the understanding that the Electric Lighting Committee would make some arrangements for sidings, the resolution was withdrawn.

Bolton.—The Bolton Corporation have recently been investigating the question of electric lighting, and it has now been decided that the town shall be supplied with the electric light. The system adopted is to be also capable of running the [illegible]

which will probably be taken over by the Corporation at the expiration of the lease next year. The capital at present sunk in the gas undertaking is over £600,000, and the profits last year were £18,000.

Bridgend — At a special meeting of the Bridgend Local Board it was decided to obtain the advice of a consulting engineer on the general scheme proposed by the Local Board, which was the outcome of their recent visits to Linton and elsewhere. Finally, Mr. Morgan Williams, of the firm of Messrs. Morgan Williams and King, was instructed to advise them in the matter. The scheme includes the use of water power to supply a portion of the requisite energy.

Birmingham. The General Purposes Committee of the Birmingham Town Council held a lengthened sitting on Monday to discuss the notice by the Electric Supply Company of their intention to apply for an additional order extending their area. The consideration of the order was postponed for 12 months. At a later stage the committee will consider whether or not they will recommend the Council to promote an order for electric lighting on behalf of the Corporation.

Chiswick. At the meeting of the Local Board, the clerk in his report stated that he had received a communication from Sir Thomas Bloomfield, of the Board of Trade, to the effect that that Board would lose no time in considering the contract of Messrs. Bourne and Grant for the provision of electric light at Chiswick. In the discussion it was pointed out that the Board of Trade had had the contract under consideration since July, and it was felt that some effort should be made to urge on the matter.

Birmingham. B. Verity and Sons, owing to the growth of their electrical engineering business in the Birmingham district, have recently taken large offices at 116, New-street, Birmingham, above the showrooms where their goods are exhibited. Their branch showrooms at Manchester, it may be mentioned, are 20, Princess-street, facing the Town Hall. All matters connected with their "Electrical Compendium," or with goods dealt in by the firm, are carried out solely by the works department at Aston, Birmingham.

Hammersmith. —The following streets were scheduled as the area to be electrically lighted in the Hammersmith district: King-street, from Broadway to Ravenscourt-park; Broadway; Hammersmith-road, from Broadway to St. Paul's School; Queen-street, from Broadway to further side of St. Paul's Church; Brook-green-road; Shepherd's Bush-road; across Shepherd's Bush-green to corner of Wood-lane. There were also added the Goldhawk-road to Starch Green Pond, and Uxbridge-road to the corner of Percy-road.

Edinburgh. — There is at last a prospect of Edinburgh following the example of the West in the matter of lighting common stairs, as a sub-committee of the Town Council have resolved to recommend that a clause should be introduced in the new Municipal Bill providing that the gas in all common stairs in the city shall be lighted and extinguished by the servants of the Corporation. The matter will be on a much more satisfactory footing, however, if electric light was used for this purpose, as the attention required by gas will be considerable.

Glasgow Tramways. —The *Glasgow Herald* continues its able articles on the "Tramway Motor Question for Glasgow," and in its article of last Friday gives, besides statistics of the Thomson-Houston and Siemens systems, a long account of the closed circuit system of Mr. Carl T. Brain, of Liverpool, whose system was recently described by us. The *Herald* comes to the conclusion that the Brain system will be more costly than a cable system for very crowded traffic, but that it would probably be useful where there is a fair traffic, though not enough to make a cable line pay.

Forest Gate. —A meeting of the Forest Gate Ratepayers' Association was held last week, Mr. Saward, deputy-chairman, presided. Mr. Sharp said he had written to the town clerk, and asked if the Town Council would permit a company to run electric light in any portion of the borough. The town clerk had replied that the Council had now obtained a provisional order empowering them to supply the electric light, and the matter would come before the Works Committee. It was agreed to defer consideration of the subject until it was known what the Town Council would propose to do.

Newbury. At the meeting of the Newbury Town Council last week, the Mayor formally moved that the cost of obtaining the electric provisional lighting order, and of the Act confirming the same, be taxed, and that it be referred to the Gas Committee to report and advise as to further proceeding of the Council in connection with the said order. Mr. Long seconded the proposition. The town clerk produced a printed copy of the Act, and in reply to a question, said he could not tell the exact costs that had been incurred in connection with this matter, but thought they would probably amount to about £300. Mr. Smith said that the sum mentioned as the probable cost of the Act when the subject was first mooted was £40. The motion was then adopted.

Windsor. —The Windsor and Eton Electric Light Company, which has been nearly four years in process of formation, has at last found itself in a position to start upon a practical scheme of operations. Matters having been arranged with the Board of Trade, the statutory notice has been served of the intention to proceed at once with the opening of streets for the purpose of laying the mains to supply the electric light, and before the end of the year it is hoped that the company's service will be available in Thames-street, High-street, and Peascod-street. The extension of time thus secured for laying the cables preserves to the company the monopoly of electric lighting in the extended area for which their provisional order was originally obtained.

Queensferry. —Some time ago the Town Council of Queensferry, Scotland, had under consideration the propriety of purchasing the gas works within the burgh, presently owned by a private company. Owing, however, to the difficulty of manufacturing gas in Queensferry at anything like a reasonable price, it was deemed advisable to make enquiries regarding other means of lighting before proceeding further in their negotiations with the gas company. Having at their command considerable water power, the Corporation are of opinion that the electric light might be introduced at almost as cheap a rate as gas; consequently, at the last meeting of the Town Council the matter was remitted to a committee, with power to employ an expert with the view of ascertaining the probable cost of such a scheme.

Queen Victoria-street Subway. The Highways Committee of the London County Council report that they have considered an application from the General Post Office for permission to place an additional four-wire cable in the Queen Victoria-street subway, between Queen-street and the Savings Bank. They are advised that there is no objection to the granting of the permission now applied for; and recommend that, subject to the provisions of the agreement between the Postmaster-General and the Council with reference to the use of the Council's subways, permission be given to the placing by the Post Office Telegraph Department of a four-wire cable in the Queen Victoria-street subway between the points mentioned in the application. They also reported various notices under Electric Lighting Acts and Orders for house connections.

Electric Tramway to Barry Island. We have it on trustworthy authority, says the *Barry Dock News*, that plans have been prepared, and the directors of the Barry Railway Company are perfecting a scheme, for the construction of an electric tramway from a point near the railway bridge at the East Barry end of the dock to Barry Island. The proprietors of Barry Island, with its charming Whitmore Bay, are determined to render it a most attractive seaside resort, and in this direction the Barry directors are prepared to lend all the assistance in their power. Already the company have anticipated the development which must take place in this respect upon the island, and the curves of the bridges have been so constructed as to admit of the formation of a tramway as proposed, and the actual laying of the rails was only deferred last year on the ground that they could be laid without any trouble when required. It is expected the electric tramway will be ready for the next summer season.

Elgin. The first installation of electric light in Elgin has recently been put into the premises of Mr. Gordon S. Shiach, L.D.S., of North Guildry-street. For some time he has used electricity in his profession, and now has installed the light throughout his house. He has a separate engine room with a Campbell gas engine, driving a dynamo at 1,900 revolutions, on the Scott-Sisling system. Two tiers of storage cells are used of the Crompton-Howell pattern. The dining room and drawing-room are lighted with two 16 c.p. lamps each, and both 8 c.p. and 16 c.p. lamps are used elsewhere. Major Grant, of Glengrant, it may be mentioned, was the first to introduce the electric light into Moray. Now that Mr. Shiach, by his enterprise, has led the way in Elgin, it is thought that in a very short time several other householders in Elgin will follow his example. The day, perhaps, may not be far distant when those who dwell near such streams as the Lossie will take advantage of the water power to drive electric machinery. We have already mentioned that the system adopted is the Scott-Sisling system of lighting, for which Messrs. R. H. Barnett and Co., Newcastle-on-Tyne, are agents for the Northern counties. The installation at North Guildry-street has been carried out by Mr. G. W. Lammis Pattison, electrician to Messrs. Barnett and Co., with complete satisfaction.

Heckmondwike. At the meeting last week of the Heckmondwike Town Council, the newly formed Electric Light Committee reported that they had held a meeting, when Mr. Wood was appointed its chairman. It was resolved that the clerk get out all the correspondence relating to the electric lighting and other companies who are prepared to contract with the Board for the lighting of the district with electricity at their own cost, and that the same be deposited for inspection by the members of the Board for the next seven days. A letter referred from the last Board meeting was read from Mr. J. H. Firth respecting electric lighting, and the clerk was instructed to acknowledge the receipt of the letter, and to inform Mr. Firth that the matter is still under discussion. A letter dated the 9th inst. was read from the Gulcher (New) Electric Lighting Company with respect to the lighting, and it was resolved that the letter be placed amongst the other letters for the inspection of this committee; that the clerk write to the Co-operative Wholesale Society, and to Messrs. J. F. Firth and Sons, Limited, asking how many electric lights they would require if the Board were prepared to supply the same at 6d. per Board of Trade unit. These minutes were confirmed. Mr. Albert Rhodes apologised to the chairman and members for having used an unparliamentary expression at the last meeting in the excitement of the discussion on the electric lighting question.

Windermere. —At the monthly meeting of the Windermere Local Board, last week, the Chairman, referring to the application for electric lighting made at last Board, as mentioned in the minutes, said the question would come before the next meeting of the committee of the County Council, and he supposed the Board would do nothing further than they had already done. Personally, he did not wish to enter on the question, as he was chairman of the gas company, but he considered the Board need not do anything to obstruct the scheme. Mr. Irving wished to know whether, providing the Board obtained an order from the Board of Trade, they could not then take over the plant after a certain time. The clerk replied that there was a difference between a

provisional order and a mere license for the purpose, but he was not sufficiently acquainted with the matter to go into details just then; besides, there was a very recent Act relating to the subject, but he thought if Mr. Fowkes's company got a provisional order the Board would not have an opportunity of taking it at less than 40 years, but if only under a license, they might acquire it at the end of seven years. Mr. Irving asked whether, supposing permission was given to lay the cable, and it proved a failure, they would be entitled to break up the roads again for the purpose of taking it up. The clerk did not know, but thought it would scarcely be worth the trouble. At any rate, they would require leave from the local authority before putting it down. The matter was eventually left as before.

Telegraph Convention between Russia and China.—A new telegraph convention between Russia and China has been signed at Pekin by the Russian Minister and the head of the Chinese telegraph administration, and now only awaits ratification by the respective Governments. Details have been brought by this week's mail. The points of junction are to be Hunchum Possiette, Holampo Blagoveschensk, and Kiachta, the first of these three to be made immediately after ratification of the treaty, the second as soon as the cable across the Amour is laid, and the third when the line from Pekin to Kiachta is constructed. It is provided that each country shall be responsible for the maintenance of the lines within its own borders, that the cable across the Amour is to be laid at the joint expense of both and to be the property of both. They agree to be bound by the rules of the Telegraphic Union, to send State messages free, to maintain the same tariff without alteration, save by common consent; and to reduce the rates if outside competition should seem to require it. The treaty is to last until December 31, 1892. By this arrangement messages between China and Asiatic Russia cost only 3.73f., and between China and European Russia 4.73f., while the rest of Europe will pay 8.50f. The treaty, it must be remembered, has still to get the ratification of the Chinese Government. By the foreign mercantile communities in China it is regarded as hostile to their interests, for its effect will be to maintain the present very high rate for messages between China and Europe.

Harwich.—A great discussion took place at the last meeting of the Harwich Town Council on the cost of obtaining the provisional order, the bill for which was £337. Mr. Rose said he should vote against it, as the town clerk had said that it would be about £150. Mr. Hill expressed surprise that Mr. Rose should vote against the bill when it was he who had been so anxious to promote electric lighting, having given his sanction when nine-tenths of the inhabitants were opposed to it. The clerk explained that the bill was that of the parliamentary agents, his own charges being put down at 10 guineas, and included several visits to London. He pointed out that the bill was entirely provided for in the estimate to be presented that day, and a 1s. rate would be sufficient. The Mayor observed that the bill fell upon them all with surprise, and upon no one more than himself and the town clerk, who, he was sure, was very much upset about it. He considered that Mr. Ward had acted very liberally, considering all the circumstances of the case. He could have sent in a bill of his own for some £40, but instead of that refused to charge except for actual expenses. The bill was passed, but subsequently Mr. Hill gave notice that at the next meeting of the Council he should move a vote of censure on those members who, knowing the wishes of nine-tenths of the ratepayers, ignored their memorial, and voted away £337 for the provisional order. Mr. Everard caused amusement by giving notice that he should also move a vote of censure on those members of the Council who promoted the opposition to the electric lighting order, and so increased the cost.

PROVISIONAL PATENTS, 1892.

OCTOBER 10.

18025. **Improvements in and relating to electric elevators.** Alonzo Bertram See and Walter Lincoln Tyler, 70, Market street, Manchester. Date applied for under Patents Act, 1883, Sec. 103, March 14, 1892, being date of application in United States.) (Complete specification.)

18037. **Improvements in electric welding apparatus.** William Charles Mountain, 3, St. Nicholas buildings, Newcastle-on-Tyne.

18039. **Improvements in electrolytic cells and diaphragms.** James Hargreaves and Thomas Bird, 4, Clayton square, Liverpool.

18066. **Improvements in electric meters.** Frederick William Golby, 36, Chancery lane, London. (Jules Adrien Djardin France.)

18077. **Improvements in electric switches.** Henry Thomas Paiste, 321, High Holborn, London. (Complete specification.)

OCTOBER 11.

18116. **Improvements in and relating to electric arc lamps.** Wilhelm Mathiesen, 70, Market street, Manchester. (Complete specification.)

[illegible]. **Improved electrical arrangement or device for the control of workmen's time checks.** Henry Davis, 52, Chancery lane, London.

[illegible]. **Improvements in and relating to conduits for electric railways.** Robert Booth, 17, Sarsfeld road, Balham, Surrey.

18154. **Improvements in electric arc lamps.** Robert Drysdale, 141, Upper Mary street, Balsall Heath, Birmingham.

18160. **Improvements in telephonic receivers.** James Philip Annett, 2, Great George street, Westminster, London.

18165. **Improvements in telephonic apparatus.** Henry Harris Lake, 45, Southampton buildings, Chancery lane, London. (Eloy Noriega, Mexico.)

18205. **Improvements connected with machinery for making articles such as telegraph insulators from plastic material.** Henry Gardner, 166, Fleet street, London. (Eduard Francke, Germany.)

OCTOBER 12.

18242. **Improvements in dynamo-electric generators and motors.** Thomas Pattison Rennoldson, Banbridge, Ireland.

18262. **Culverts for electric mains made with pipes or tubes with insulators at intervals, arranged so that the conductors can be drawn in after the culverts are laid.** William Harding Scott, Gothic Works, King street, Norwich.

18280. **Improved construction of grid plates for holding the active material in secondary batteries.** Henry Gardner, 166, Fleet-street, London. (Eduard Francke, Germany.)

18295. **Improvements in methods of and means for the production electrically of spectacular effects.** Alexander Leslie Fyfe, 22, Southampton-buildings, Chancery lane, London.

OCTOBER 13.

18337. **Improvements in the construction of electrical switches.** Samuel Thomas Wyand and Louis Schramm, 9, Warwick court, Gray's Inn, London.

18350. **Improvements in electric regulators.** Albert Lewis Davis, 25, Southampton buildings, Chancery lane, London.

18363. **Improvements in or relating to dynamo electric machines.** John Potter Thomas, 323, High Holborn, London.

OCTOBER 14.

18399. **Combined telephone switch and ringing key.** Richard Whitehead and Alfred Dovey, 7, Well road, Heeley, Sheffield. (Complete specification.)

18452. **Improvements in the manufacture of zinc rods for electrical bells and batteries.** John Green and George Turner, 4, South street, Finsbury, London.

OCTOBER 15.

18465. **Improvements in electromagnetic sounding apparatus.** Frederick William Golby, 36, Chancery lane, London. (Paul Binsfeld and Harry von Gleissenberg, Germany.)

18505. **Improvements in or relating to the supply of electricity to aerial machines.** Charles Casalonga, 40, Lincoln's inn fields, London.

18516. **Improvements in and relating to the electro deposition of metals.** Ernest Noel Alexis Picard and Jean Anne Fauvre, 4, South street, Finsbury, London. (Complete specification.)

18520. **Improved telephone transmitter and receiver.** Robert Kirk Boyle, 106, Clapham road, London.

SPECIFICATIONS PUBLISHED.

1879.

2552. **Electric lamps.** Siemens. (Alteneck.) (Second edition.)

1890.

13485. **Electrical glow lamp conductors.** White. (Second edition.)

1891.

14234*. **Electric railways.** Catford. (Amended.)

18733. **Electric telephonic apparatus.** Marr and Collier.

20230. **Electric arc lamps.** Rider.

1892.

4185. **Galvanic battery.** Stiens.

14035. **Electric incandescent lamps.** Pinter.

14056. **Electric motors.** Lake. (Stanley and another.)

14769. **Brushes for dynamos.** Thompson. (Cherry and others.)

14928. **Non-sparking switch.** Molhurst.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	[illegible]
Brush Co.	–	[illegible]
– Pref.	–	[illegible]
City of London		[illegible]
Electric Construction	10	[illegible]
Gatti's	—	[illegible]
House-to-House	5	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]
London Electric Supply	5	[illegible]
Metropolitan Electric Supply	—	[illegible]
National Telephone	5	[illegible]
St. James'	—	[illegible]
Swan United	[illegible]	[illegible]
Westminster Electric	—	[illegible]

NOTES.

Tyrol.—An electric railway 27 miles long, between Riva and Pinzolo, in the Tyrol, is projected.

Technical School.—The Spring Gardens mill at Bacup is being fitted up as a technical school.

Russian Telephones.—It is stated that the Russian Government intends to buy up the telephone lines in its dominion.

Asnieres.—The central electric station at Asnières, France, has been completely destroyed by fire, the damage being 80,000f.

Budapest.—The firm of Ganz and Co., of Budapest, have recently added to their already large works an electro chemical laboratory.

Electro-Harmonic.—The smoking concert of the Electro-Harmonic Society will take place to-night (Friday) at St. James's Hall Banqueting-room.

Aluminium.—According to M. Mannesmann, a little tungsten added to pure aluminium obviates all difficulty from attack by water, salt water or otherwise.

Electrical Manufacture of Chemicals.—A great fuss is being made in certain quarters about the direct manufacture of chemicals from brine by electricity. As yet we have not much faith in this discovery.

Junior Engineering Society.—The inaugural meeting of the session of this society will be held on Friday, November 4, at 8 p.m., at the Westminster Palace Hotel. The presidential address will be given by Dr. John Hopkinson, F.R.S.

Sherborne.—An exhibition installation is on view at Sherborne, containing wind engines for electric light, policemen's lamps, gas and petroleum engines, and so forth, and there is room for other exhibits if anyone is desirous of showing goods.

Raguse.—A central station has just been started in the town of Raguse. Water power is supplied by two turbines of 100 h.p. The whole of the electric part of the installation has been carried out by MM. Brown, Boveri, et Cie., of Baden, Switzerland.

Electric Sewing Machines. — A large costume establishment of Paris is being fitted by M. Jaques Uhlmann with electrically-driven sewing machines. The current, at 110 volts, is taken from the street mains, and each motor takes two amperes.

Camberwell.—The Camberwell Vestry have set a good example by giving the necessary power to the General Purposes Committee to secure the services of a gentleman to lecture at the Vestry Hall on "How to Light Camberwell by Electricity." The name of the lecturer has not transpired.

Taxation of Machinery.—A mill in Sunderland was assessed recently at £450 increase. On appeal, the assessment, instead of being increased, was decreased by £400. This case should encourage manufacturers to resist unfair assessments. The case was in the hands of Mr. G. Humphrey Davies, surveyor to the Associated Manufacturers.

Wimshurst Machine.—The Wimshurst induction machines have a strange fascination for experimentalists, and many electricians are doing their best to lead the wayward high-tension spark to a useful purpose in lighting or other application. Sir Archibald Campbell has, we are told, an 80-plate machine driven by a motor for experimental work.

Luxurious Train.—Messrs. Brown, Marshall, and Co., of Saltley, have just built a most luxurious train for the P. and O. service, to run between Calais and Brindisi, fitted with every requisite that comfort can suggest. Electric bells are used throughout, and we suppose small sets of storage electric lamps will also be used, though this is not stated.

Electric Railway in Hungary.—A large scheme is promulgated by Messrs. Ganz and Co. for the construction of an electric railway between Vienna and Budapest. The first project submitted to M. Baros, the Hungarian Minister of Commerce, has been refused approval, but other plans are being prepared, and it is yet hoped the scheme may receive approval.

Household Lighting.—Books on house lighting by electricity are in the air. We have already noticed one recently published, and we are now informed that another will be issued shortly under the title of "Household Electric Lighting," by Mr. Angelo Fabie, M.I.E.E.; paper cover 1s. 6d., cloth 2s. 6d. Publishers: Spon and Co., London; J. Falconer, Dublin. The book will be fully illustrated.

Chicago Telephone.—The tests made with the Chicago-New York long-distance telephone line have not been entirely satisfactory, though sufficiently so to give promise that the difficulties will be overcome. The music of a cornet was distinctly transmitted, but speech less distinctly, though it was possible to communicate. The charge is 9dol., or 38s., for five minutes' conversation. It is not likely to be much used at this rate.

Medals.—At the meeting of the Institution of Engineers and Shipbuilders in Scotland the medals and premiums awarded at the annual general meeting of the institution, held in April, were presented. Among these were premiums of books awarded to Mr. Henry A. Mavor for his paper on "The Development of Electric Distribution;" to Prof. Andrew Jamieson, F.R.S.E., etc., for his paper on "The Electric Lighting of Public Buildings."

Telephonic Telegrams.—Dolyddelen, in Wales, has long yearned for telegraphic communication. It has hitherto received nothing but official notices on large sheets of blue paper of the necessity of a warranty of income. Now, however, posts are erected not for a telegraph line, but for telephones, and everybody is satisfied. The connection is to the charming resort of Bettws-y-Coed, loved of artists and tourists. If they stray to Dolyddelen, they are not now beyond reach of the outside world.

Liverpool University College.—The first excursion of the Walker Engineering Laboratory, Liverpool University College, took place last week to the Highfield-street central station of the Liverpool Electric Supply Company, by kind permission of Mr. A. M. Holmes, engineer to the company. The party (40 in number), accompanied by Prof. Hele Shaw, were conducted through the works by Mr. Holmes, who explained each department, including the boiler-house, accumulator-rooms, and dynamo, transformer, and engine rooms, explaining the methods of supply and testing.

Electricity in Mines.—In a leading article in the *Iron and Steel Trades Journal* it is pointed out that electric coal-cutters "would be much improved if adapted to drill in any direction besides the vertical without disturbing the horizontal position of the framework." After alluding to the benefits of electric locomotives for hauling, our contemporary remarks that there is a good field for electric railroads with overhead conductors for mining districts, "as the water power heretofore neglected is being called

into service and the transmission of power to distant points is becoming the necessity of the future."

Soleure.—The Compagnie de l'Industrie Electrique, of Geneva, has just been awarded the contract for the complete installation of a central electric station and mains necessary for the lighting and transmission of power for the town of Soleure. The central station will include two Thury continuous-current dynamos, driven by turbines and coupled in series, giving a pressure of 6,400 volts for transmitting 365 h.p. a distance of 28 kilometres (16½ miles). We hope to give full details of this interesting installation when it has started work.

Coast Communication in Kent.—With a view to advancing the interests of the seafaring community, and also to increasing the facilities for saving life at sea, electric communication has been greatly improved along the Kentish coast. Broadstairs, Ramsgate, and Margate are now telegraphically connected with Lloyd's signal station, North Foreland. The North Sandhead lightship, Goodwin Sands, will, it is now stated, be connected by cable with the station to be erected at Dumpton Gap, about half-way between Broadstairs and Ramsgate. At this station a man will be constantly on duty.

Colour Photography.—M. Lippmann has been pursuing with energy his investigations into colour photography. He says that "on the layers of albumino-bromide of silver rendered orthochromatic by azaline and cyanine, I obtained very brilliant photographs of spectra. All the colours came out at once, even the red, without the interposition of coloured screens, and after an exposure of from five to thirty seconds." He submitted photographs of stained-glass windows, draperies, oranges, and a parrot, taken by electric light with five to ten minutes' exposure, in which the colour is noticeable as well as the form.

Edison Lamps.—It is understood that the General Electric Company has no intention of attempting to squash the other American lamp manufacturers, nor take steps to raise the price. Licenses will probably be issued to manufacturers at a reasonable royalty. The present plant of the General Electric Company would not be sufficient to cope with the monopoly, nor would it probably be wise to increase the factory for the short time the patent has yet to run. The Westinghouse Company are intending to take up immediately the manufacture of a new type of lamp which it is claimed does not infringe upon the Edison patent.

Decimal System.—The New Decimal Association has recently issued a new prospectus, which shows that the general committee consists of 14 members of the House of Lords, principal among whom on the science side is Lord Kelvin, 27 members of Parliament, representatives of 37 Chambers of Commerce, 27 Trades Councils, and numbers of bankers, engineers, electricians, and merchants. It is expected that the day is not far distant when the decimal system will be taught alongside the other in every Board school, and when this is done the extension of the knowledge of the system to the public will be a matter of a few years only.

Multiphase System.—The *Electrical World* learns that in New England a plant is to be installed this month, using a multiphase generator and motor, each of 300 h.p. capacity, to transmit power from a waterfall 11½ miles distance. The motor will be used to drive dynamos, to supply the current for street lighting. We should have thought transformers would have been simpler. Electric tramway considerations may be in view, for our contemporary adds, "Such service would be an ideal one for driving railway generators, owing to the steadiness of running and the fact that violent fluctuations of load that are such a prominent feature of railway operation produce an inappreciable effect on the speed of multiphase motors."

Messrs. Whittaker and Co. announce Prof. Oliver Lodge's "Treatise on Lightning Conductors and Lightning Guards"; "A Comprehensive Work on the Dynamo," by C. C. Hawkins and F. Wallis; "The Principles of Fitting for Engineer Students and others"; "Electrical Experiments," by G. E. Bonney; "Practical Electric Light Fitting," by F. C. Allsop; "Electric Lighting and Power Distribution," by W. Perren Maycock, M.I.E.E.; "How to Manage a Dynamo," by S. R. Bottone; "Electricity and Magnetism," by S. R. Bottone; "Chemistry," by T. Bolas, F.I.C., F.C.S.; "Geology," by A. J. Jukes Browne, F.G.S.; and other volumes.

American Storage Battery Monopoly.—After a struggle lasting for about ten years, beginning in the Patent Office and carried successively through the United States Circuit Courts in several states, the United States Circuit Court of Appeals, on the 4th inst., handed down a decision sustaining the decree of Judge Coxe rendered in July, 1891, in the suit of the Brush Company against the Electrical Accumulator Company. The sole right to use storage batteries with the active matter mechanically applied is now owned by the Consolidated Electric Storage Company, the licensees of the Brush Electric Company. Consequently, says the *Scientific American*, this decision gives to the Consolidated Electric Storage Company a monopoly of the storage battery business throughout the United States for a period of over 10 years next ensuing.

Glasgow Omnibus.—It seems that the Glasgow Tramway Company, ready with improvements, started an omnibus on Saturday, not only electrically lighted but furnished with pneumatic tyres. The omnibus moves with the greatest smoothness and noiselessness. The seats inside, which are covered with crimson velvet, are mounted on springs, which adds much to the comfort. The electric lamp is fixed in the roof, supplied from a battery underneath one of the seats containing a sufficient storage of electrical energy for 24 hours. Twelve passengers can be carried inside and 14 outside. The tyres on the wheels measure about 3½in. in diameter, and can withstand a pressure of 187lb to the square inch. To guard against any risk of the indiarubber being punctured by sharp stones or otherwise the tyres are thoroughly protected by several plies of canvas, together with a covering of wire wove netting. The improved 'bus is much appreciated.

Electro-Therapeutics.—Our contemporary the *Western Electrician* has a note commending the action of the London *Electrical Review* in its creditable work of exposing quackery. We are in accord with our contemporaries and would point out that technical journals are oftimes placed in a pecuniary loss by their action concerning "quackery." It is by no means uncommon to receive copy for an advertisement at a high price from advertising agents of good standing. Greatly to the credit of what may be termed the representative technical journals of this country, all such advertisements are instantly refused. There is no doubt that either the *Electrical Review* or ourselves could benefit to the tune possibly of hundreds of pounds were the restrictions concerning such advertisements withdrawn. When, then, a technical journal abandons its silence and undertakes, in self-defence, an aggressive policy, it is the interest of its colleagues and the industry generally to support the good work.

Electric Fountain at Craig-y-Nos.—M. Gustave Trouvé has just finished a commission for an electric fountain at Craig-y-Nos, the Welsh mountain home of Madame Patti-Nicolini. The basin of the fountain is 20ft. diameter

and the jets are illuminated by four 200-c.p. incandescent lamps. The light is projected on the jets by means of four parabolic reflectors under the glass-covered chambers, from which the water springs. The tints are given to the light by interposing coloured glasses arranged on two superposed discs, concentric or otherwise, which are turned in the same or opposite directions with equal or unequal velocities by means of a small waterwheel. By this means the play of colour on the water can be diversified like that of the kaleidoscope. Each of the lamps consume six amperes at 110 volts. Mr. Trouvé was assisted in carrying out this electric fountain by Mr. Surridge. There is also a brilliant search-light on the tower at Craig-y-Nos, which is brilliant enough to be seen 14 miles away. Craig-y-Nos has now the right to be called a veritable electrical palace.

Gearless Motors.—An improved gearless motor has been brought out by the Short Electric Railway Company in America. The chief points of this new motor, of which great things are expected for heavy work, are that it weighs 2,300lb. for 20 to 25 h.p. motors, and is capable of being coupled direct to 30in. wheels. It is triangular in shape, and has 13 field magnets cast integrally with the frame, and three consequent pole-pieces, making a six-pole machine of peculiar form. The frame is of cast steel, and every part is utilised in the magnetic circuit. It is waterproof, has only two brushes (carbon). The copper capacity is very large. Friction and hysteresis are reduced to a minimum, and its efficiency reaches nearly 90 per cent. at one part of its load. Two motors are intended to be used on each car, and in series will make 10 miles an hour, and in parallel about 20 miles an hour. The motors are made about 20 h.p. for the ordinary street railroads, but will be made of larger size for interurban traffic. The motor is to be shown and tested at the National Street Railway Convention at Cleveland.

Electrical Coast Communication.—The resolution of the House of Commons passed last session, on the motion of Sir Edward Birkbeck, Bart., on behalf of the Royal National Lifeboat Institution, relative to the establishment of a complete system of electrical communication on our coasts, has already produced good results, many of the coastguard stations and post offices on the most dangerous parts of the coast having already been telephonically or telegraphically connected with the view of giving early notice to the lifeboats that their services are required. During the recent storm there were no less than three instances in which the newly-established telephone wires proved of service. At Brancaster the lifeboat was called out by a telephone message from the coastguard at Thornham and saved five lives. At Hunstanton the lifeboat crew were promptly assembled in response to a telephonic message, but the necessary assistance was given by another boat; while at Wenterton the telephone was successfully used to secure the services of a tug from Yarmouth to tow out the lifeboat to assist a wreck on the Happisburgh Sands.

Ozone.—The commercial manufacture of ozone, which was carried on in London by Mr. Ernest Fahrig a year or two ago, has been undertaken by him on a more extended scale in Marseilles, Illinois. The Fahrig process consists in the manufacture of oxygen from peroxide of manganese and hydrate of soda and lime, and its ozonisation by electricity. The installation is established in connection with the American Ozonised Water Company, and is described in a recent number of the *Western Electrician*. Ozone is found a much stronger and far less harmful bleacher than chlorine, and is now used for the blanching of spices, treatment of table-water for killing the germs, preservation of tinned meats, fish, and milk, the ageing of wines, oxidation of oils, destruction of bad matters, bleaching of linen, silk, ivory, bones, sponges, and other materials. The ozone industry, under Mr. Fahrig's earnest and persevering endeavours, promises to become an important one, and is an example both of the usefulness of electricity and also of the utility in the present state of the electrical industry for an experimenter to take some specimen field of manufacture, create a demand, and himself fulfil this demand.

Accumulator Traction.—The notice issued recently by the Electrical Power Storage Company of their willingness to undertake accumulator traction at a fixed and not too large proportion of the total receipts, has aroused a considerable feeling of interest and even of surety that at last something may be done with the ugly duckling of British electrical engineering — tramcar traction. We hope the matter will speedily turn out successful, and, if so, there will be all the greater encouragement for inventors to deal with the lightening of the weight of the batteries. The enormous weight of three tons now carried, according to Mr. Dickenson, on the Birmingham trams, is evidently ridiculous. Attention is directed on the Continent, as will be seen by a note, to the lightening of weight, but the hints given in our last issue as the result of Mr. Desmond FitzGerald's experiments in gilding lead are, in our opinion, more likely than investigations in any other direction to prove a practical solution of the weight difficulty. Meanwhile, Mr. Frank King is convinced of the safety of his policy, and we understand that several very large projects are under consideration.

Nelson.—The works for the supply of Nelson (Lancs.) with electric light have been commenced. The station is for 600 16-c.p. lamps, and applications for over 300 lamps have been received. The dynamo will give 360 amperes at 110 volts. Of main cable 1,550 yards will be laid. The cable itself will be composed of 61 copper wires, forming almost a solid copper bar, covered with pure vulcanised indiarubber and coated with hemp and tar. The cable will be 1⅜in. in diameter. Cast-iron troughs in 6ft. lengths, each weighing 2¼cwt., will be used, and to prevent the admission of water, and thus preserve the insulation of the cable, the covers of the troughs will be packed with solid indiarubber, with also indiarubber packings between the troughs. Tapping-boxes will be placed at intervals. From the tapping-box the wires are conveyed in glass-lined wrought-iron tubes, 1¼in. in diameter, to small junction-boxes, very similar in construction to the tapping-boxes. From each of these boxes the current will be conveyed in two glass-lined tubes to the premises of consumers. The designing of the scheme has been carried out by Mr. John Foster, the assistant gas manager, and the establishment of the installation will be carried out under his supervision.

Boulogne-sur-Mer.—The central electric station of Boulogne is situated nearly outside the town, three-quarters of a mile from the centre of the town, close alongside its principal customer, the railway station. The distribution is carried on by the three-wire system and accumulators. Two Weyher and Richemond condensing engines of 125 h.p. drive two Desroziers dynamos of 250 amperes, and 300 to 350 volts, and a smaller dynamo of the same make giving 130 amperes at 120 volts. The latter charges the accumulators specially installed for the railway station, arranged in two groups of 92 cells, taking 130 amperes charging current, with their own switchboard. From the other dynamos mains are led to a sub-station of batteries of 130 cells, with an output of 400 amperes. A hand-regulator is used to vary the cells in charge and discharge, and by a special arrangement used here, it is believed, for the first time, the set of batteries can be connected up

differently every day to equalise the charge and discharge of the two sides of the system. The mains are all underground, insulated cables being used placed on glass insulators in an earthenware trough. A depression in the bottom of the trough serves to carry off any condensed water, and the system has given excellent results during the 18 months it has been at work. The price of current is 12 centimes per hecto-watt, or very nearly 1s. per supply unit.

Westinghouse Incandescent Lamp.—The following particulars of the new lamp, which it is claimed does not infringe the Edison patent, are volunteered by the Westinghouse Company: "The new lamp differs radically from those now in use. It requires no platinum, and is made in separate parts, so that the burner can be renewed, and the bulb and other parts used over and over again. Furthermore, by means of an important discovery, the burner is rendered stable, its efficiency increased, its life prolonged, and its normal candle power maintained. The manufacture of these lamps will be carried on almost entirely by machinery, the first cost being thus reduced, so that with the advantages obtained from the reuse of bulbs, a saving of from 30 to 50 per cent. to consumers in the cost of incandescent lamps for a given service will be effected. These lamps are in appearance a decided improvement over those now in use, and when used with a new socket designed for the purpose a further reduction in cost of lamp renewals will be effected, as no base attachment is required to make connection with the socket." Important allowances will also be made for return of bulbs to the factory. It is seen that the Westinghouse Company are certainly not content to set down tamely under the Edison monopoly. It is necessary to point out that only the second claim of Edison's patent is upheld, the other three claims having been held by the Court not to be infringed. The lamp is made under the old Sawyer Man patent.

Waste Coal.—We are accustomed to dissertations on the enormous wastefulness of the present methods of using coal for steam engines, but it would seem in reality as if the waste were often greater underground than above ground. Such is stated to be the case by Mr. James Tonge, F G S., in the course of a paper read by him recently before the members of the North Staffordshire Mining Institute. It is quite possible that here electricity may come to the aid of colliery managers, with specially designed coal-cutters for the various class of coal, for the waste alluded to is mostly in the breaking of the coal into almost valueless slack. It would really seem as if the best thing to be done at the present time would be to obtain carefully digested reports as to the exact state of the requirements for collieries in hauling, cutting, lighting, signalling, and testing for dangerous gases. Fully put before electrical engineers from the colliery engineer's point of view, there would probably be little time before the requirements would be fully and exactly satisfied. Is it not worth the while of the Mining Institute, or some body like the Society of Arts or our own Institution, to formally apply for and report upon the present requirements of colliery engineers? It would lead to better and more economical methods of colliery work, and show the exact fields of business that are open to electric motor men and electric lampmakers, while secondary-battery makers, dynamo and wire makers would all participate in the benefit.

Chamber of Commerce.—A meeting of the Electrical Trades' Section of the London Chamber of Commerce was held last Friday, at the offices of the Chamber, Botolph House, Eastcheap, at which the rules and regulations of the Board of Trade regarding the electrical industry were discussed. The chair was occupied by Major Flood Page. Mr. Crompton alluded to the correspondence between the section and the Board of Trade in 1890 relative to two of the Board's rules as to overhead wires—the thickness of insulation and suspending wires. They were given to understand at the time that the Board would not consent to modify these rules, as requested, until they had been pressed to do so by some authority as influential as the Council of the Institute of Electrical Engineers, which originally advised them. He had accordingly communicated with the Institute, and Prof. Ayrton had at once taken the matter up, and a committee of the Institute had been appointed to go into it. It was quite clear, however, that the investigation desired by them must now be wider than that originally contemplated, and must, in fact, embrace the whole subject of the Board's interference with the electrical industry. He did not believe that Parliament had ever intended that the Board of Trade should deal with them in regard to matters of the smallest detail. M. Emile Garcké, the Chairman, General Webber, and other gentlemen took part in the discussion, the general feeling being that it would be advisable in the first place to try and induce the Council of the Institute of Electrical Engineers to modify the advice which they originally gave to the Board of Trade. Eventually a resolution was passed appointing a sub-committee of the section to consider the whole question of the regulations of the Board of Trade, and to confer with the Institute of Electrical Engineers.

Information.—Not only should we call attention to the long series of articles which are appearing in the *Belfast Evening Telegraph*, but we should also refer to an excellent series of articles—which has been concluded with the eleventh article—in the *Glasgow Herald*, on the tramway motor question. A vast amount of information has been disseminated in this manner, and so far as we can see the information has been fairly given. A number of the more important firms which have carried out traction work are mentioned, but we should like to add a little information about a short line, which to us is somewhat unique. Southend is fairly well known as possessing a pier over a mile and a quarter in length, and having on this pier an electric tram line which was constructed by Messrs. Crompton and Co. We think this line has been running, during the season, now for something like three years. The engine is one of Davey-Paxman's, and has never given any trouble; the dynamo is one of Crompton's, and also has given no trouble. The engineer in charge of this installation must be congratulated that, with no second dynamo, he has been able during the whole of this period, not only to run the tramcars as required, but also to light the pier with arc lights and the pavilion with incandescent lights. None but those who have had charge of an installation with what may be termed no stand-by, will understand the responsibility which attaches to the keeping of everything in due order for the multitudinous work. As we say, this line is a mile and a quarter in length, and we imagine that what can be done on the mile and a quarter can be done on a line twice or 10 times the length with the necessary suitable apparatus. We understand that, during this slack season, the installation at Southend is to be thoroughly overhauled.

The Institution.—The next meeting of the Institution takes place on November 10, and our contributor, Mr. S. F. Walker, has taken the opportunity of giving expression to opinions which, to say the least, are not quite favourable to the administrative system of the Institution. But Mr. Walker suffers in not being behind the scenes

quite so much as the papers he refers to. The dealings of the Institution with the technical press are much on a par with the proceedings of the heathen Chinee. Readers of our esteemed contemporary, the *Electrical Review*, may remember towards the end of the spring session it had occasion to call attention to the vacillating policy of the Institution. We hardly considered the matter worth attention, but we find some of the members are by no means pleased with the condition of affairs. Let us recall the matter. In earlier days the technical papers were allowed to make their own reports. Then came a time of authorised reports, which meant that the papers and reports were officially sent to the various editors. Towards the end of the spring session these official reports were stopped. Our contemporary, like others, made its own arrangements, but these were officially objected to. What will be the course pursued during the forthcoming session, we neither know nor care. It would not be difficult to give the names of the busybodies on the Council to whose initiative these proceedings are due, but the Electrical Engineers are not in the habit of worshipping such heroes. In our opinion the official reports were fairly satisfactory, and might well have been continued. Mr. Walker, however, is quite right in his contention, that *some*, not all the members of Council, have the idea that the Institution is run for their special benefit. He is right, also, in the discreditable way in which men are elected—men who have not the remotest knowledge of aught electrical, nor any pretence to such knowledge.

Dejardin's Electric Meter.—M. Déjardin, the well-known constructor of the Jacquemier and Marès meters, has himself brought out a new watt-hour meter with almost continuous integration. His object has been to provide a strongly-built cheap meter, giving exact readings, and using less current than is usual in most meters. His meter consists of an electrodynamometer, a weighing mechanism, clockwork movement, and totalising gear. The electrodynamometer is composed of a movable fine-wire coil between two fixed thick-wire coils, the latter wound inversely to act similarly upon the thin-wire coil; the thick coils take the whole current measured, and the thin coil is in shunt. The movable thin coil is connected to a balance beam by means of a suspension rod, and the couple it exerts under the influence of the current is proportional to E I. The method of integration is peculiar. The balance arm of the weighing mechanism is furnished with a wheel, which, when the beam is in an horizontal position, gears with the clockwork of a 40-day pendulum clock; this latter is, by its construction, connected to the totaliser every five minutes. The movable coil is connected to a very flexible chain, known in Paris as a "chaine de regence"; this it pulls over in proportion to its displacement. The clockwork on connection winds back the chain until a sufficient length is unwound to overcome the weight of the balance arm, when it swings down, coming out of gear, and stopping, of course, the registration. The chain is wound off continuously during the five minutes' interval, and if after a reading is finished more lamps are thrown on, the balance goes up at once and the supplement of energy used is registered. The registration is thus continuous, except for a period of two or three seconds in each period of five minutes, when the chain is being wound back into place, and the integration is thus continuous for 297 seconds out of every 300. The expenditure of current is practically nil, as the movement is carried out by clockwork, but meters are also made with automatic electric winding. Three screws are supplied to keep the movable parts in place for safety in transport. Illustrations of the Déjardin meter are given in *L'Electricien* for October 22, with description, of which the above is a short abstract.

Theory of Accumulators.—M. Bidard, professor of chemistry at Rouen, has recently expounded his theory of the action of lead accumulators. This theory is published in the *Bulletin Internationale de l'Electricité*, and the author considers that it "explains all the interactions of accumulators, and will lead to important improvements in their manufacture"—viz: (1) Reduction of volume and weight of cells; (2) greater conductivity and abrogation of alteration of lead; and (3) rendering the actual output much nearer to the theoretical output. He first of all states as an absolute principle that no other accumulator is possible than lead immersed in sulphuric acid, and that with other metals "accumulation" cannot take place. The theory of accumulators, he says, is of great simplicity, and may be thus defined: When a current of electricity is passed between two plates of lead insulated and placed in sulphuric acid solution, the acid is decomposed into sulphur, which combines with one of the plates to form a black sulphite of lead, and oxygen, the latter attacking the other plate to form brown peroxide of lead. The chemical formula is thus:

$$2\,SO_3 + 5\,Pb = 2\,S\,Pb\text{—black sulphite of lead.}$$
$$3\,Pb\,O_2\text{—brown peroxide of lead.}$$

This reaction shows itself by the two distinct colours brown and black. This is further confirmed by analysis. From numerous experiments the important fact has been proved, that after charge the accumulator becomes heavier by the weight of the fixed oxygen and sulphur, and consequently a part of the sulphuric acid of the solution disappears, and its elements are to be found in the sulphite of lead and the peroxide. When the cell is discharged the two elements, sulphur and oxygen, fixed in the lead recombine to form sulphuric acid. These important experiments can be easily reproduced with small plates of lead in a glass vessel. M. Bidard considers that no "accumulation" is possible except with lead, as the lead, sulphite of lead, and peroxide are neither attacked nor even altered by sulphuric acid. It is otherwise with copper, iron, or zinc, which do not resist sulphuric acid, as the acid will dissolve their oxides. Lead is the only metal which enables "the two electricities" to be fixed in their solid combinations—sulphite and peroxide of lead, insoluble in sulphuric acid. The lead must be as pure and as divided as possible, and old metal from pipes, spouts, etc., must be avoided, as these contain noticeable quantities of zinc, and even antimony, which give rise to troublesome actions and tend to destroy the plates. The sulphuric acid of commerce is sufficiently pure: it contains sulphate of lead, which is separated when it is mixed with water sufficient to bring it to 10deg. This should be removed by deposition or filtration to prevent it forming a coating on the plates. To arrive at perfection with accumulators there yet remains, says M. Bidard, several problems to be solved: 1. For a certain quantity of lead what is the "quantity of electricity accumulated"? 2. What is the best method of obtaining divided lead? 3. Preservation of the plates when not in use, and means of cleaning without taking to pieces to remove the sulphate. 4. By employing sulphuric acid of 10deg. there is always electrolysis of a certain amount of water, hence waste of electricity—research is needed to find if this can be avoided by employing acid of greater density. This is the professor's note upon his new theory, which, heralded with some *éclat*, is to greatly improve the manufacture of accumulators. The terminology, as will be seen, is loose for a scientific theory, and it hardly seems as if this disquisition, though stating the matter succinctly, will add greatly to the present knowledge of the action of secondary cells.

LIFE AND EFFICIENCY TESTS ON INCANDESCENT LAMPS, WITH A FORMULA FOR DETERMINING THE RELATIVE VALUES OF THE DIFFERENT MAKES OF LAMPS.*

BY P. G. GOSSLER

The following is an account of a life and efficiency test on various makes of incandescent lamps, made in the testing room of a large electrical illuminating company. The object of the test was to determine the best lamp for central station use, by which is meant a lamp that is most satisfactory to the customer, and at the same time most economical to the illuminating company. The results are of a special value from the fact that throughout the test the conditions under which the lamps were run, were made to conform with the conditions imposed upon lamps in central station practice.

Ten different kinds of lamps were secured for the test, most of them coming from the storeroom of the illuminating company, or bought in the open market. Twenty lamps were taken at random from each lot of lamps, and carefully measured for candle power and current consumption at 50 or 100 volts, according to the markings on the lamps. The lamps were placed on a large lampboard which had been made for the purpose, having heavy copper bars at the bottom, which were fed from a bank of converters on the three wire system. The 50-volt lamps were so connected that the two sides of the three wire system were equally balanced, the 100 volt lamps being connected to the outside wires of the same system. This arrangement secures exact equality of voltage on all of the 200 lamps placed on the board, except that the voltage on the 100 volt lamps was double the voltage on the 50-volt lamps. The rated capacity of the bank converters, to which the 200 lamps were connected, was 240 lamps. A number of lamps broke during the first few hours of the test, which reduced the load on the converters to about three quarters of the rated capacity, this being approximately the average load in practice. The bank of converters was connected to the distributing mains of a commercial circuit, to which about 2,200 commercial incandescent lamps were connected, and the lamps in the test board burned under the same conditions of pressure as the lamps in customers' premises. The lamps were burned continuously, candle-power and current measurements being made at a pressure of 50 and 100 volts when the lamps were new, and after they had burned 100, 300, 600, 1,000, and 1,700 hours. The voltage at which the lamps burned in the lampboard was measured by a standard voltmeter, the measurements being made as often as 30 times a day during the early part of the test, but this was not continued during the entire time, the measurements being made but three or four times a day during the latter part of the test. It is shown in the tables that the average E.M.F. on the 50 volt lamps was from 51 to 52 volts, while on the 100 volt lamps it was double this. No effort was made to keep the current and E.M.F. on the lamps constant at 50 volts during the life test, the lamps being burned at the average voltage on the circuit from which they were fed. The average E.M.F., as stated in the tables, was from 51 to 52 volts. However, it was carefully controlled during the candle-power and current measurements, all measurements being made at 50 and 100 volts. The arrangements provided secured for the lamps in the test room the same conditions as to voltage, etc., that they had on the other lamps that were connected to the station, and especially the lamps connected to the distribution mains, from which the test-room drew its supply of current. After the 200 lamps had run 400 or 500 hours, a second test was started on five of the 50 volt makes, which seemed to be leading in the early part of the first test. The purpose of the second test was to find the effect on the lamps of increasing the pressure about 10 per cent. For this purpose 10 new lamps of each of the five kinds were placed on a second lampboard, with converters so connected that they would burn at 10 per cent higher pressure than the lamps in the first test. The 50 volt lamps in the first test are lettered A, C, E, H, J, L, O, and P, and the 100 volt lamps are lettered G and J. The lamps in the second test are lettered B, D, F, K, and N.

There are in all 15 groups of lamps, representing 13 groups of 50-volt lamps, and two 100 volt groups. The 13 groups of 50-volt lamps represent but eight different makes, five makes in the first test being duplicated in the second test. The two 100 volt groups in the first test were made by the same makers as two of the 50 volt groups. The tables and curves for the same kinds of lamps are lettered as follows: A and B are of the same make, C and D are of one make, E and F are the same, and J and K are the same, and those lettered L and N are of the same make.

The 100-volt group marked G is from the same factory as the 50 volt lamps marked H, and the 100 volt group marked I is of the same make as those marked L and N. The last measurements were made after the test had been running 1,700 hours, and it will be seen from the second and fifth columns, in the same tables, that there are [illegible] lamps that would not be considered dead for ordinary lighting purposes, especially on circuits that are run as this test circuit was, at an average voltage of 2 per cent to 4 per cent. above that for which the candle-power measurements were made.

The candle-power measurements were made on an ordinary Bunsen sliding photometer, the scale of which was 96in. in length, and marked to read directly in candles

B.—50-Volt 16 c.p. Lamps. Voltage about 10 per cent. [illegible]

Hours burned.	No. of lamps.	No. of lamps broken.	Average current per lamp amperes.	Average c.p. per lamp.	Per cent. of c.p.	Per cent. loss of c.p.	Watts per candle.	Total lamp hours burned.	Lamp hours burned per light installed.	Average volts on lamps.
0	10	0	·96	17·4	100	0	2·72	0		
100	9	1	·95	12	69	31	3·95	957	95·7	[illegible]
200	5	5	·96	10	57·5	42·5	4·8	1,622·8	162·3	[illegible]
300	3	7	·96	8·1	48·3	51·7	5·8	2,522·8	252·3	[illegible]
400	2	8	·96	8·2	47·2	52·8	5·85	2,724·8	272·5	[illegible]
500	2	8	·96	7·4	42·5	57·5	6·5	2,904·8	290·5	[illegible]

D.—50-Volt 16 c.p. Lamps. Voltage about 10 per cent. [illegible]

0	10	0	1·03	17·3	100	0	2·97	0		
100	10	0	1·00	15·18	88	12	3·3	1,000	100	[illegible]
200	7	3	1·00	12·8	74	26	3·9	1,838	183·8	[illegible]
300	*2	8	1·00	10·4	60·2	39·8	4·8	2,157	215·7	[illegible]

* Broke between 300 and 400 hours.

F.—50-Volt 16 c.p. Lamps. Voltage about 10 per cent. [illegible]

0	10	0	1·07	14·6	100	0	3·06	0		
100	10	0	1·06	14·34	98·3	1·7	3·69	1,000	100	[illegible]
200	7	3	1·06	13	89	11	4·07	1,848	184·8	[illegible]
300	6	4	1·06	11·2	76·7	23·3	4·73	2,448	244·8	[illegible]
400	6	4	1·06	9·85	67·5	32·5	5·38	3,048	304·8	[illegible]
500	6	4	1·06	9·06	62·2	37·8	5·85	3,648	364·8	[illegible]
600	2	8	1·06	7·6	52	49	6·97	4,060	406	[illegible]
800	1	9	1·06	7·5	51·4	48·6	7·06	4,428	442·8	[illegible]
900	1	9	1·06	7·4	50·7	49·3	7·16	4,528	452·8	[illegible]

K.—50-Volt 16 c.p. Lamps. Voltage about 10 per cent. [illegible]

0	10	0	1·00	14·5	100	0	3·46	0		
100	10	0	1·00	14·04	97	3	3·56	1,000	100	[illegible]
200	8	2	1·00	12	83	17	4·15	1,896	189·6	[illegible]
300	7	3	1·00	10·9	75·22	24·8	4·58	2,630	263	[illegible]
400	7	3	1·00	9·97	68·8	31·2	5·01	[illegible]	[illegible]	[illegible]
500	6	4	1·00	9·3	64·2	35·8	5·37	[illegible]	[illegible]	[illegible]
600	5	5	1·00	7·9	54·5	45·5	6·33	[illegible]	[illegible]	[illegible]
800	2	8	1·00	7	48·3	51·7	7·14	5,157	515·7	[illegible]
900	2	8	1·00	7·3	50·4	49·6	6·85	5,357	535·7	[illegible]

N.—50-Volt 16 c.p. Lamps. Voltage about 10 per cent. [illegible]

0	10	0	1·00	11·9	100	0	3·37	0		
100	9	1	1·00	13·3	89·3	10·7	3·75	957	95·7	[illegible]
200	6	4	1·00	11·3	76	24	4·42	1,774	177·4	[illegible]
300	4	6	1·00	9·8	65·8	34·2	5·10	2,244	224·4	[illegible]
400	3	7	1·00	8·5	55·7	44·3	6·02	[illegible]	[illegible]	[illegible]
500	3	7	1·00	8·25	55·3	44·7	6·07	[illegible]	[illegible]	[illegible]
600	1	9	1·00	7·7	51·7	48·3	6·50	[illegible]	[illegible]	[illegible]

* From the *Electrical World* (New York).

A.—50-Volt 16 c.p. Lamps.

Hours burned.	Number of lamps.	No. of lamps broken.	Average current per lamp, amperes.	Average c.p. per lamp.	Per cent. of c.p.	Per cent. loss of c.p.	Watts per candle.	Total lamp-hours burned.	Lamp-hours burned per light installed.	Average voltage on lamps.	Remarks. E.M.F. on lamps.
0	20	0	·972	16·52	100	0	2·95	0			Volts.
100	20	0	·96	17·74	107·4		2·7	2,000	100	50·94	Mx. 53·2 Mn. 49 7
300	19	1	·975	13·5	81·8	18·2	3·61	5,882	294·1	51·3	Mx. 53 4 Mn. 49 8
600	10	10	·98	10·9	65·7	34·3	4·49	10,105	505·3	52·2	Mx. 54 Mn. 50·3
1,000	3	17	·98	8·83	53·5	46·5	5·54	12,622 8	631·1	52	Mx. 53·7 Mn. 51·5
1,700	1	19	1·15	7·7	46·6	53·4	7·47	13,397·8	669·9	51 8	Mx. 54 Mn. 50

C.—50-Volt 16-c.p. Lamps.

Hours burned.	Number of lamps.	No. of lamps broken.	Average current per lamp, amperes.	Average c.p. per lamp.	Per cent. of c.p.	Per cent. loss of c.p.	Watts per candle.	Total lamp-hours burned.	Lamp-hours burned per light installed.	Average voltage on lamps.	Remarks. E.M.F. on lamps.
0	20	0	1·04	16·1	100	0	3·21	0			
100	20	0	·99	16·6	103		2·98	2,000	100	50·94	Mx. 53·2 Mn. 49·7
300	17	3	1·048	15	93·2	6·8	3·49	5,767	288·4	51·3	Mx. 53 4 Mn. 49·8
600	14	6	1·05	12·6	78·3	21·7	4·17	10,374	518 7	52·2	Mx. 54 Mn. 50·3
1,000	4	16	1·14	11	68·4	31·6	5·18	13,331·8	666·6	52	Mx. 53·7 Mn. 51 5
1,700	2	18	1·34	9·5	59·1	40·9	7·05	14,843·8	742·2	51·8	Mx. 54 Mn. 50

E.—50-Volt 16-c.p. Lamps.

Hours burned.	Number of lamps.	No. of lamps broken.	Average current per lamp, amperes.	Average c.p. per lamp.	Per cent. of c.p.	Per cent. loss of c.p.	Watts per candle.	Total lamp-hours burned.	Lamp-hours burned per light installed.	Average voltage on lamps.	Remarks. E.M.F. on lamps.
0	20	0	1·031	14·47	100	0	3 56	0			
100	20	0	·97	13·1	90·6	9·4	3·7	2,000	100	50·94	Mx. 53·2 Mn. 49 7
300	20	0	1·034	13·5	93·3	6·7	3·83	6,000	[illegible]	51 3	Mx. 53·4 Mn. 49 8
600	15	5	1·03	12·8	88·5	11·5	4·04	11,198	559·9	52·2	Mx. 54 Mn. 50 3
1,000	11	9	·98	11·1	76·7	23·3	4·41	16,525·8	826 3	52	Mx. 53·7 Mn. 51 5
1,700	7	13	1·01	9·85	68·1	31·9	5·12	21,832·8	1091·6	51·8	Mx. 54 Mn. 50

G.—100-Volt 16-c.p. Lamps.

Hours burned.	Number of lamps.	No. of lamps broken.	Average current per lamp, amperes.	Average c.p. per lamp.	Per cent. of c.p.	Per cent. loss of c.p.	Watts per candle.	Total lamp-hours burned.	Lamp-hours burned per light installed.	Average voltage on lamps.	Remarks. E.M.F. on lamps.
0	20	0	·463	12·0	100	0	3·82	0			
100	20	0	·45	10·67	88·2	11·8	4·21	2,000·	100·	101·88	Mx. 106·4 Mn. 99 4
300	19	1	·468	8·97	74·2	25·8	5·21	5,870·	293 5	102 6	Mx. 105 8 Mn. 99·6
600	16	4	·47	7·6	63	37	6·18	11,601	580	104·4	Mx. 108 Mn. 100 6
1,000	11	9	·45	6·27	51·8	48·2	7·17	16,133·5	806·6	104	Mx. 107·4 Mn. 103
1,700	8	12	·45	5·7	47·5	52·5	7·89	22,564·5	1,128·2	103 6	Mx. 108 Mn. [illegible]

H.—50-Volt 16-c.p. Lamps.

Hours burned.	Number of lamps.	No. of lamps broken.	Average current per lamp, amperes.	Average c.p. per lamp.	Per cent. of c.p.	Per cent. loss of c.p.	Watts per candle.	Total lamp-hours burned.	Lamp-hours burned per light installed.	Average voltage on lamps.	Remarks. E.M.F. on lamps.
0	20	0	·896	10·47	100	0	4 29	0			
100	15	5	·85	8·79	84	16	4·83	1,764	88·2	50·94	Mx. 53 2 Mn. 49 7
*300	13	7	·80	6·9	66	34	5·79	4,424	232·8	51·3	Mx. 53·4 Mn. 49·8
600	11	9	·79	6·4	61·2	38·8	6·17	8,094	426	52·2	Mx. 54 Mn. 50 3
1,000	10	10	·74	4·9	46·8	53·2	7·75	12,355	650	52	Mx. 53 7 Mn 51·5
†1,700	6	14	·87	3·3	31·6	68·4	13·2	17,845·5	939 3	51·8	Mx. 54 Mn 50

* One lamp broken accidentally. † One lamp too dull to measure candle-power.

I.—100-Volt 16-c.p. Lamps.

Hours burned.	Number of lamps.	No. of lamps broken.	Average current per lamp, amperes.	Average c.p. per lamp.	Per cent. of c.p.	Per cent. loss of c.p.	Watts per candle.	Total lamp-hours burned.	Lamp-hours burned per light installed.	Average voltage on lamps.	Remarks. E.M.F. on lamps.
0	20	0	·517	15·4	100	0	3·35	0			Volts.
100	19	1	·475	12·6	81·8	18·2	3·77	1,915·	95·8	101·88	Mx. 106 4 Mn. 99·4
300	17	3	[illegible]	11·7	76	24	4.13	5,567·	278·3	102·6	Mx. 106·8 Mn, 99·6
600	15	5	·49	9·6	62 4	37·6	5·1	10,475·5	523·8	104·4	Mx. 108 Mn. 100·6
1,000	12	8	·45	7·4	48·7	51·3	6 08	15,755·8	787·8	104	Mx 107·4 Mn. 103
1,700	12	8	·46	5·8	37·7	62·3	7·93	24,155·8	1,207·8	103·6	Mx. 108 Mn. 100

J.—50-Volt 16-c.p. Lamps.

Hours burned.	Number of lamps.	No. of lamps broken.	Average current per lamp, amperes.	Average c.p. per lamp.	Per cent. of c.p.	Per cent. loss of c.p.	Watts per candle.	Total lamp-hours burned.	Lamp-hours burned per light installed.	Average voltage on lamps.	Remarks. E.M.F. on lamps.
0	20	0	1·01	15·9	100	0	3 16	0			
100	19	1	·96	15·2	95·6	4 4	3·15	1,954·5	97·8	50·94	Mx. 53·2 Mn. 49·7
300	16	4	1·013	13·9	87·5	12·5	3·65	5,369·5	268·5	51·3	Mx. 53·4 Mn. 49 8
600	12	8	1·02	12·2	77	23	4·18	9,583·5	479·2	52·2	Mx. 54 Mn. 50 3
1,000	8	12	·96	10·1	63·5	36·5	4·75	13,382·7	669·2	52	Mx. 53·7 Mn. 51·5
*1,700	6	14	·97	6·8	42·8	57·2	7·13	18,090·8	904·6	51·8	Mx. 54 Mn. 50

* C.P. of one lamp too low to measure.

L.—50-Volt 16-c.p. Lamps.

Hours burned.	Number of lamps.	No. of lamps broken.	Average current per lamp, amperes.	Average c.p. per lamp.	Per cent. of c.p.	Per cent. loss of c.p.	Watts per candle.	Total lamp-hours burned.	Lamp-hours burned per light installed.	Average voltage on lamps.	Remarks. E.M.F. on lamps.
0	20	0	1·032	15 94	100	0	3·23				
100	19	1	·98	12·5	78·6	21·4	3 92	1,914·8	95·7	50·94	Mx. 53·2 Mn. 49·7
300	18	2	1·026	12	75 3	24·7	4 27	5,654·8	282 7	51·3	Mx. 53·4 Mn. 49·8
600	17	3	1 03	11·8	74·1	25 9	4·36	10,943·8	574·1	52·2	Mx. 54 Mn. 50·3
1,000	12	8	1	10·03	66 5	33·5	4 85	17,054·8	852·8	52	Mx. 53·7 Mn. 51·5
1,700	10	10	1·03	9 6	60·3	39·7	5·37	24,440·8	1,222·1	51·8	Mx. 54 Mn. 50

O.—50-Volt 16-c.p. Lamps.

Hours burned.	Number of lamps.	No. of lamps broken.	Average current per lamp, amperes.	Average c.p. per lamp.	Per cent. of c.p.	Per cent. loss of c.p.	Watts per candle.	Total lamp-hours burned.	Lamp-hours burned per light installed.	Average voltage on lamps.	Remarks. E.M.F. on lamps.
0	20	0	1·017	15·45	[illegible]	0	3·29				
100	16	4	1·09	15·5	100·3		3·51	1,772·7	88·64	50·94	Mx 53·2 Mn. 49·7
*300	13	7	·989	13·6	87·8	12·2	3·63	4,838	241·9	51·3	Mx. 53·4 Mn. 49·8
600	7	11	·99	12·04	77·9	22·1	4·11	7,071	366	52·2	Mx. 54 Mn. 50·3
1,000	1	17	·99	9·7	62·8	37·2	5·11	8,928·5	469	52	Mx. 53 7 Mn. 51·5
†1,700	1	17						9,628·5	508	51·8	Mx. 54 Mn. 50

* Two lamps broken by accident. † Discarded.

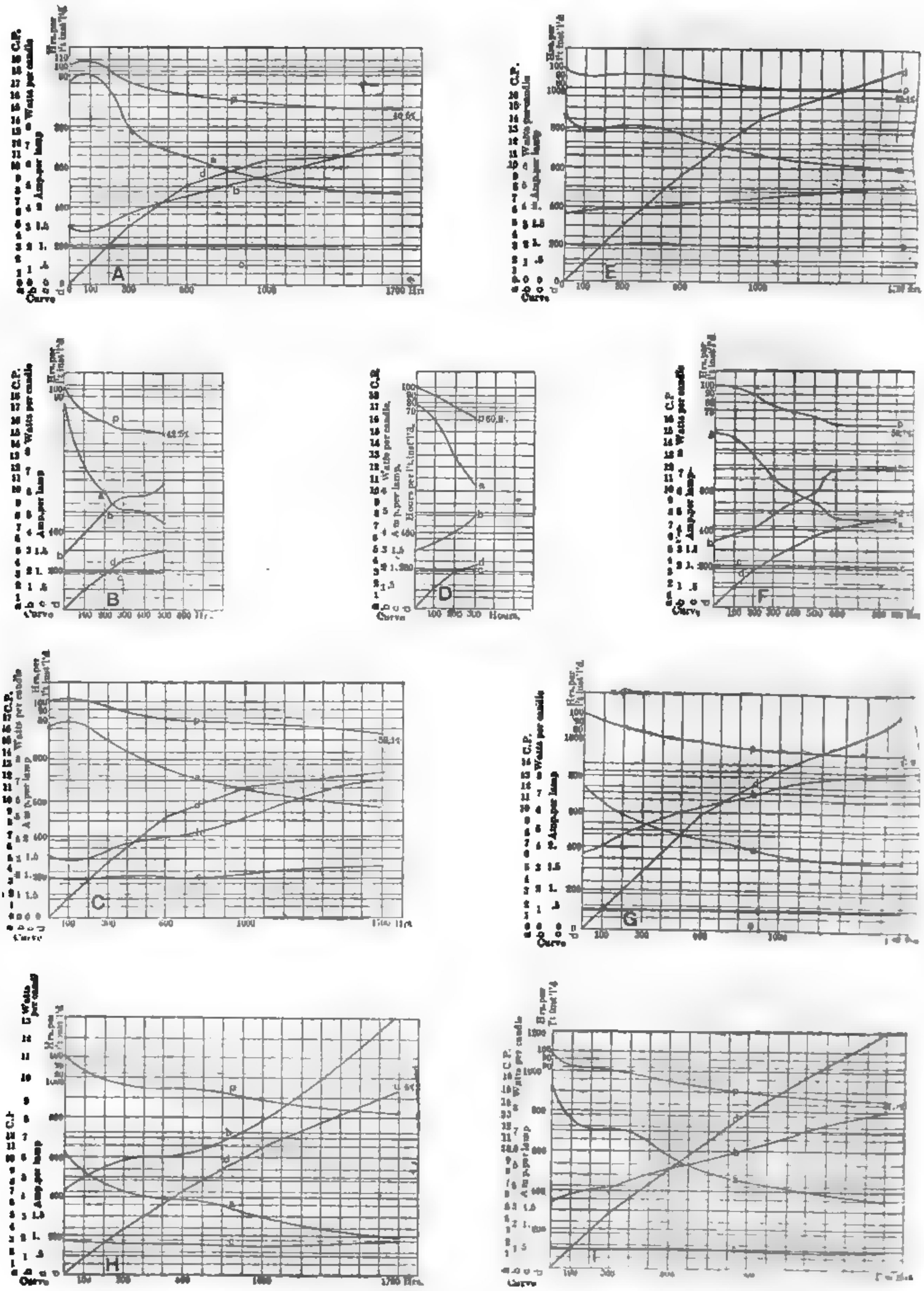
P.—50-Volt 16-c.p. Lamps.

Hours burned.	Number of lamps.	No. of lamps broken.	Average current per lamp, amperes.	Average c.p. per lamp.	Per cent. of c.p.	Per cent. loss of c.p.	Watts per candle.	Total lamp-hours burned.	Lamp-hours burned per light installed.	Average voltage on lamps.	Remarks. E.M.F. on lamps.
0	20	0	·996	15·63	100	0	3·12	[illegible]			
100	17	3	·97	15·2	97·3	2·7	3·18	1,784·5	89·23	50·94	Mx. 53·2 Mn. 49·7
300	14	6	·997	12·8	81·9	18·1	3·89	5,079	253·9	51·3	Mx. 53·4 Mn 49 8
600	8	12	1·00	11·6	74·2	25·8	4·31	8,629	431·5	52·2	Mx. 54 Mn. 50·3
1,000	2	18	1·00	10·25	65·7	34·3	4·87	10,827·8	541·4	52	Mx 53 7 Mn 51 5
*								13,618·5	680·9	51 8	Mx. 54 Mn. 50

* Lamps all broken.

The standard used was a selected incandescent lamp, placed on the same circuit as the lamp being measured. The object of doing this was to secure comparative candle-power measurements that would be correct for all the lamps at exactly 50 volts, and any error from unavoidable variations in voltage on the lamp being measured was approximately neutralised by the varying of the voltage on the standard to exactly the same extent, or keeping the voltage on the two lamps exactly equal. More accurate comparative measurements were secured in this manner than can be had when an ordinary gas standard of candle-power is used. The standard lamps were secured by

taking 100 lamps and seasoning them by burning them 10 hours at a high voltage, and selecting from these as standards lamps which measured 16 candles. The efficiency of the were made with two Siemens electro-dynamometers. The lamps were measured for current in groups of 10, and the average current of the group taken.

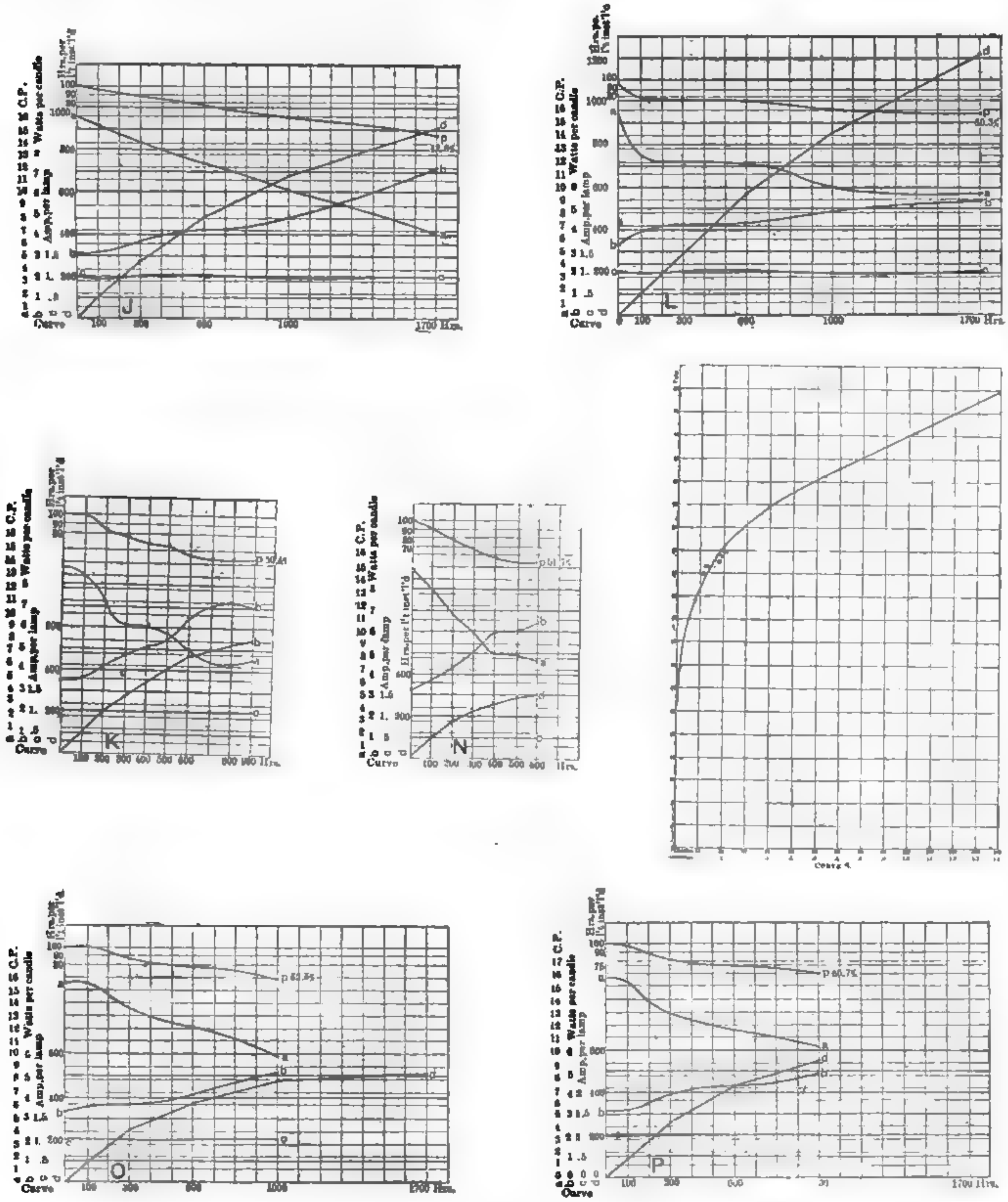


Curves A, B, C, D, E, F, G, H, and I, showing the Results of Life and Efficiency Tests of Incandescent Lamps.

standard lamps was approximately the same as that of those being measured. The voltage was taken by means of a carefully standardised voltmeter, and the current measurements

The results of the tests on the different makes of lamps are given in the tables and plates, for which the following explanation will be sufficient. Each group of 20 lamps is

designated by a letter, and the plates bear the same letters as the tables, from which they are constructed. The curves on the different plates, representing the same thing, are all drawn on the same scale and bear the same letter throughout, as on plate A, curve A represents the candle-power, measured at 50 volts, at various stages during the test; B is the curve representing the watts per candle, at 50 volts; C the curve giving the refer to curve A, and represent average candles per lamp at 50 volts; the vertical row lettered "b" refers to curve B, and represents average watts per candle at 50 volts; the vertical row "c" refers to curve C, and represents the average amperes per lamp at 50 volts for all unbroken lamps; the vertical row "d" refers to curve D, and represents the average hours burned per lamp-hour, burned by all of the lamps, referred to by the curve, divided



CURVES J, K, L, N, O, P, showing the Results of Life and Efficiency Tests of Incandescent Lamps.

amperes per lamp at 50 volts; P gives the percentage of the initial candle-power; and D gives the number of hours burned per lamp, installed for any of the time intervals at which the measurements were made; time is a factor common in all of the curves. The figures at the bottom of the plates, in horizontal rows, are common to all the curves, and represent hours that each lamp has burned. The vertical rows of figures lettered "a" by the total number of lamps originally installed in the given lot, which was either 20 or 10. The curves on the plates have been plotted from the observations made at the different periods of the time shown in the tables, and each curve represents the average result of all the measurements made on the particular lot of lamps to which it refers.

Lamps burning at a voltage above that for which they

are rated give a much greater illuminating power than 16 candles, but at the same time their life is very considerably shortened. A plate showing the effect of various voltages upon the brilliancy of a lamp is given, and the effect of a 10 per cent. increase of voltage upon the lamp may be ascertained from the tables and plates by comparing the same makes of lamps which were run in the two tests The lamps lettered L and N are of the same make, and are the lamps referred to as having been taken directly from the storeroom; but it is seen from the tables that the initial tests on these lamps vary considerably, which is accounted for by the lamps coming from different invoices, received from the manufacturers at different times. It has been observed that lamps received from the factory do not average the same candle-power and efficiency for different invoices; that is, lamps which are received in one invoice are usually quite uniform throughout that lot, but they vary considerably from lamps made at other times. Plate 8 gives the curve showing the different illuminating powers of a 16-c.p. 50-volt 52-watt lamp, for various voltages from 25 to 80 volts. The table from which this curve has been plotted is as follows:

Volts.	Amperes.	Candles.	Watts.
25	·561	·4	14·025
29·5	·645	·87	19·03
34·6	·774	2·47	26·94
40·	·898	5·1	35·92
48·	·9675	12·6	46·34
49·	1·032	15·	50 57
50·	1·055	15·8	52·75
52·5	1·0965	20·50	57·57
55·6	1·161	28 40	64·55
59·5	1·2255	39·30	72·92
62·	1·29	50·70	79·98
68·2	1·419	74·50	96 78
72·5	1·4835	103·20	107·54
78·	1·548	130·	120·74
80·	1·58	141·	126·40

From this curve can be approximately ascertained the candle-power at which the lamps in the test burned. All candle-power measurements in the test were made with the lamps in the position of maximum horizontal candle-power.

The question which first presents itself after an examination of the above tables and curves is, which is the best lamp for central station use? To get a satisfactory answer to this, all of the conditions surrounding the initial cost, and cost of operating the plant, will have to be considered.

For this purpose the cost of producing light may be divided into three parts, as follows:

A. That portion of the cost of service per lamp-hour that is not affected by the average efficiency and life of the lamps, and such portion of the maintenance, operating and general expenses as is not increased by increasing the current consumption per lamp-hour.

B. The cost per lamp-hour for coal, water, interest, and depreciation on lines, dynamos, engines, etc., and such part of the expense of the service as increases proportionally to the amount of current served per lamp-hour, and as the maximum station output.

C. The cost of the lamps per lamp hour, and the expenses per lamp-hour of replacing exhausted lamps, which is equal to the cost of one lamp plus the cost of exchanging one exhausted lamp, divided by the average life of the lamps.

These divisions should be made so that the sum of A, B, and C will represent the total cost of service per lamp-hour. That part of the cost, exclusive of lamp renewals, that does not increase with an increase of current per lamp-hour should be classified under A. That portion of the cost of service per lamp-hour, exclusive of the cost of renewing lamps, that increases proportionally to the current consumed per lamp-hour, should be classified under B. Under the first division A is the cost of shades, sockets, fuses, fixtures, subsidiary cables and ducts, etc., and such proportion of the operating and general expenses as it is not increased by increasing the current consumption per lamp-hour.

The values of A, B, and C, representing the above divisions of cost, having once been established for a lamp of any given efficiency and length of life for any particular central station, the cost of service per lamp-hour for this same station with any other lamp which has a current consumption of x times the current consumption per lamp-hour of the first lamp, and having an average life of y hours, would be

$$A + x B + C',$$

C′ being the cost of one of the new lamps, plus the cost of replacing one exhausted lamp, divided by y, the average hours of life of the new lamp. Substituting in the formula approximate values for the above expressions, and applying the assumed values to the three makes of lamps lettered J, I, and H, we get the following:

Let the cost of service per lamp-hour of a central station burning lamps L (see curve L), having an average life, under actual conditions, of 1,200 hours, a current consumption of 51·5 watts at 50 volts, or 53 watts per lamp at the actual voltage burned in use, an average candle-power during the life of 10·7 candles per lamp, when measured at 50 volts, or an average candle-power of 12·2 candles at the actual voltage burned, be as follows:

A— ·45 cents.
B— ·28 cents.
C— {Cost of lamp, 50 cents.
Cost of exchanging one exhausted lamp, 1·5 cents.
Average lamp life, 1,200 hours.

Substituting these in the formula, we have

$$\cdot45 + (\cdot28 + 1) + \frac{50 + 1\cdot5}{1{,}200} = \cdot7729 \text{ cent,}$$

which is the cost per lamp-hour for supplying light with the make of lamps lettered L.

Let the cost of service per lamp-hour of a central station burning lamps J (see curve J) having an average life under actual conditions of 700 hours, a current consumption of 50·5 watts per lamp, at 50 volts, or 52 watts per lamp, at the actual voltage burned in the test, and having an average candle-power during life of 12·2 candles when measured at 50 volts, or an average of 14·1 candles when measured at actual voltage burned be:

A— ·45 cents.
B— ·28 cents.
C— {Cost of lamp, 40 cents.
Cost of exchanging one exhausted lamp, 1.5 cents
Average lamp life, 700 hours.

$$x - \frac{1\cdot01}{1\cdot03} = \cdot98.$$

Substituting in the formula,

$$\cdot45 + (\cdot28 \times \cdot98) + \frac{40 + 1\cdot5}{700} = \cdot7886 \text{ cent,}$$

the cost per lamp-hour for supplying light with the lamps lettered J.

It is seen that the cost of service per lamp-hour is less with the lamps lettered L than with the lamps lettered J, but if we find the cost of service for candle-power of light given by dividing the cost per lamp-hour of both makes by the average candle-power given by the respective lamps while burning, we have for the lamps L, $\frac{\cdot7729}{12\cdot2} = \cdot0633$ cent, equals the cost per candle-power hour, and for the lamps J $\frac{\cdot7836}{14\cdot1} = \cdot0555$ cent equals the cost per candle-power hour, making a difference of ·0078 cent per candle-power hour in favour of the lamps lettered J, which have the cheaper initial cost of the two makes, L and J.

Applying the formula the same way to find the cost of service per lamp-hour under the same conditions as above, and using the lamps H, we have the following:

Let the cost of service per lamp-hour of a central station burning lamps H (see curve H), having an average life under actual conditions of 375 hours (this being a very liberal allowance for this lamp), and having an average current consumption of 44·8 watts per lamp at 50 volts, or 46 watts at the actual voltage burned in the test, and

having an average candle-power during life of 7·6 candles, when measured at 50 volts, or an average of 9·1 candles, when measured at the actual voltage burned, be:

A— ·45 cents.
B— ·28 cents.

$$C\text{—}\begin{cases}\text{Cost of lamp, 30 cents.}\\ \text{Cost of exchanging one exhausted lamp, 1·5 cents.}\\ \text{Average lamp life, 375 hours.}\end{cases}$$

$$x\text{—}\quad \frac{\cdot896}{1\cdot03} = \cdot87$$

Substituting in the formula,

$$\cdot45 + (\cdot28 \times \cdot87) + \frac{30 + 1\,5}{\cdot375} = \cdot778 \text{ cent},$$

which is the cost per lamp-hour for supplying light with the make of lamps lettered H, under conditions assumed.

Dividing the cost of service per lamp-hour with the lamps H, by their average candle-power per hour, under the above conditions, we have $\frac{\cdot778}{9\cdot1}$ = ·0855 cent per candle-power hour, making a difference of ·0222 cent per candle-power hour in favour of the lamps lettered L, and a difference of ·03 cent per candle-power hour in favour of the lamps lettered J.

This formula applies only for comparing the cost of producing light with lamps having different costs, efficiency, and average lamp life, when they are to be burned in the same plant and under the same conditions of average lamp-hours burned per lamp installed, and the same maximum number of lamps burning for a given number of lamps wired, etc. Value B in this formula includes the coal consumption and the materials, which practically vary proportionally to the watt-hours output required for providing the light. It also includes the interest and depreciation on the plant, which must be enlarged when the lamps consume large amounts of current, because the generating and supplying capacity of the plant must be proportional to the maximum output called for by the lamps. In many plants the interest and depreciation account will form quite a considerable portion of the factor B, and as a large value to the factor B makes a showing against a high consumption of current per candle-power hour very bad it would appear that any lamps installed in a plant that did not burn at the time of maximum current output from the station could be economically used of a poorer efficiency with longer life than lamps that do burn at the time of maximum output, because any additional demand for current on a plant that is not a call for a current at the time of maximum output does not require an increase of plant capacity. In estimating the best efficiency per candle-power hour, or per lamp-hour, for these lamps that do not burn at the time of maximum output, the cost of interest and depreciation entering into the factor B in the formula (in fact, all the costs that increase proportionally as the size of the plant required to serve the lights wired) should be excluded from the factor B; the result is that lamps that do not burn at the time of maximum output can be economically used of considerably lower efficiency than lamps that do burn at that time.

BOARD OF TRADE REPORT.

The following completes the appendix to the Board of Trade report as given in recent issues.—Ed. *E. E.*

LICENSES.

Title of License.	To whom granted.	Revoked or repealed.
	1884.	
Colchester Electric Lighting License, 1884.	South-Eastern (Brush) Electric Light and Power Co., Ld.	Expired July 14, 1891.
	1885.	
Dalton-in-Furness Electric Lighting License, 1885.	The Local Board.	—
St. Austell Electric Lighting License, 1885.	John Edward Veale.	—
	1886.	
Dundalk Electric Lighting License, 1886.	The Town Commissioners.	—
	1887.	
Kensington Court Electric Lighting License, 1887.	Kensington Court Electric Lighting Co., Ld.	Repealed by the Kensington and Knightsbridge Electric Lighting Order, 1889.
	1888.	
Kensington Court Electric Lighting License, 1888.	Kensington Court Electric Lighting Co., Ld.	Do. do.
Liverpool Electric Lighting License, 1888.	Liverpool Electric Supply Co., Ld.	Repealed by the Liverpool Electric Lighting Order, 1889.
St. James's Electric Lighting License, 1888.	St. James's and Pall Mall Electric Light Co., Ld.	Repealed by the St. James's Electric Lighting Order, 1890.
	1889.	
Dublin Electric Lighting License (Public), 1889.	The Corporation.	The Dublin Electric Lighting Order, 1892, scheduled to the Electric Lighting Orders Confirmation (No. 4) Bill, now before Parliament, contains a provision for the repeal of this license.
Kensington Electric Lighting License, 1889.	Kensington Court Electric Lighting Co., Ld.	Repealed by the Kensington and Knightsbridge Electric Lighting Order, 1889.
Wimbledon Electric Lighting License, 1889.	The Local Board.	—
	1890.	
Bath Electric Lighting License, 1890.	Henry George Massingham.	—
Chelmsford Electric Lighting License, 1890.	Crompton and Co., Ld.	—
Dublin Electric Lighting License (Private), 1890.	The Corporation.	The Dublin Electric Lighting Order, 1892, scheduled to the Electric Lighting Orders Confirmation (No. 4) Bill, now before Parliament, contains a provision for the repeal of this license.
Newcastle and District Electric Lighting Company's License, 1890.	Newcastle and District Electric Lighting Co., Ld.	Repealed by the Newcastle-upon-Tyne Electric Lighting Order, 1891.
Newcastle-upon-Tyne Electric Supply Company's License, 1890.	Newcastle-upon-Tyne Electric Supply Co., Ld.	—
Northampton Electric Lighting License, 1890.	Northampton Electric Light and Power Co., Ld.	Repealed by the Northampton Electric Order, 1890.
Southampton Electric Lighting License, 1890.	Southampton Electric Light and Power Co., Ld.	—

THE

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TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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THE BOARD OF TRADE AND THE INDUSTRY

Practically a meeting of the Electrical Trades' Section of the London Chamber of Commerce was held last Friday to discuss the relations between the Board of Trade and the industry. It is fine fun to have a Government department to kick—nobody is hurt; nobody takes the kicking seriously. It is assumed that the kickers have their own ends to pursue, and try to do so to the best advantage. Everybody agrees that a Government department always needs a gentle kicking, otherwise its existence would be intolerable. It treads on toes and corns, and pursues its way somewhat unconcernedly. It is given to closing its eyes and going ahead, thereby conferring sundry knocks on those who stand in its way. It is easy to formulate a tolerably lengthy list of ills which men, and especially business men, have to suffer because of the interference of a department which, after all, doesn't care a pin for the business men. Putting it bluntly, we have on the one hand an industry the members of which are intent—and all credit to them for being so—on making money. They are rather arrogant in their ways of proceeding, prone to tell you that you know nothing at all of the business in hand, cynical in the presence of any suggestion other than they make themselves, and quite certain they are right and everybody else wrong. On the other side we have a department with certain advisers—independent of business concerns—standing in the way. Naturally inert, hard not merely to convince but to allow possibility of conviction outside of formal red tapeism, is it to be wondered at that friction arises? Rather ought we not to wonder that so little friction has arisen. Mr. Crompton, in moving that a committee should be appointed to deal with the matter made some sweeping assertions that may tend to roughen, rather than soften the way of the department: "The whole question of the extent to which the Board of Trade should interfere with private electrical enterprise should be very carefully considered, and if they found that they were really having their hands tied and the progress of their industry fettered by being over-regulated, they must make an energetic protest against the continuance of such over-regulation." There is no one who knows better than Mr Crompton that so far as interference in "private electrical enterprise" is concerned, there is none. It is only when the industry comes into conflict with the general public that difficulties arise. This is clear from other sentences. "His own view was that the Board of Trade had no business to interfere in the matter of electrical supply, except in so far as regarded the protection of the safety and of the interests of the public, and also as regarded accounts and the transfer of electrical undertakings. Parliament never intended that the Board of Trade should regulate the industry in the smallest details." Here we take leave to differ from Mr. Crompton. Parliament intended that the public should be safe, and the Board of Trade is compelled to enter into the minutest details of electric supply in order to ensure this safety. If there were no black sheep in the electrical fold, a good many details could be left to the industry to arrange; but the Board of Trade has to legislate for the black sheep, and thus,

in many cases, hangs a millstone round the necks of those who are honest, and who believe in a name and reputation for good work. It is only in details which affect the public that the Board of Trade interferes. If a private installation is put up in a gentleman's house or in a factory, the Board of Trade has nothing to say in the matter. The only three people concerned are the purchaser, the seller, and the fire insurance offices. You may, so far as the Board of Trade is concerned, put up overhead or underground wires, or no wires at all—you may use high pressure or low pressure. They do not legislate in this case. We hold that the Board of Trade, even with its inertness, has pursued a fairly beneficial policy so far as the development of the industry is concerned, in that it has shown a decided preference towards municipal action—hence we cannot quite accept any sweeping condemnation of the Board of Trade officials. They have responsibilities, and it is better for them to be on the safe side, rather than on a too lenient footing. What we would like to see — what we would support to the utmost — is an increase in the flexibility of the Board of Trade's rulings. Let their rules differ from those of the Medes and Persians—let red-tape acknowledge and act upon the fact that circumstances alter cases; that, for example, there are certain times and places where overhead wires are practicable, where a variation of insulation will cause no harm, and where a relaxation of rules will not endanger the safety of man, woman, or child, but would give an opportunity for an installation that under the rigid rules cannot be carried out.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

A DISCLAIMER.

SIR,—I see with great regret that my former colleague and collaborateur in various communications to the Institution of Electrical Engineers and other scientific societies, Dr. Arthur Harries, has issued a report in favour of the electropathic belts of Mr. Harness.

I must therefore ask to be kind enough to allow me to make known through your columns that my connection with Dr. Harries ceased about a year ago.—Yours, etc.,

H. NEWMAN LAWRENCE, M.I.E.E.

WRITING ON THE CLOUDS.

SIR,—On Thursday night, October 6th, 1892, from the grounds of the camp of the "Buffalo Bill's Wild West," we succeeded in placing the luminous letters "B U F" on the clouds, which letters were seen by hundreds of people, and from a good number of whom we received congratulations on having accomplished this surprising scientific feat.

From that date to the present time we have frequently repeated the experiment, and have placed Colonel Cody's portrait, not only on the clouds, but also on artificially-made clouds and on a secondary beam of light as a background.

These experiments have been witnessed by hundreds of people, and were carried on under the auspices of Colonel Cody (Buffalo Bill) and Mr. Edward Curtice, whose invention we were engaged in developing.—Yours, etc.,

R. J. CANAVAN, Superintending Electrician,
H. JACKSON, Electrician,
Earl's Court Exhibition, Oct. 24th, 1892.

P.S.—The above invention is being demonstrated at Messrs. Crompton and Co.'s works, Lillie Bridge-road, West Brompton, every evening this week after 8 p.m.

REVIEWS.

Electric Traction. By ANTHONY RECKENZAUN, C.E., M.I.E.E. Biggs and Co., Salisbury-court, Fleet-street.

The issue of a book devoted solely to electric traction is an indication of the growth of this branch of electrical engineering, and also of the need for specialists in every industry. Mr. Reckenzaun states in the preface of his book that "he has endeavoured to make it a concise summary of the methods now in use, and of the steps which have led to the present stages in the perfection of the art of electric traction."

Our first impression on reading this book is that it is in places prejudiced by its conciseness. It is throughout crowded with most valuable information, the results of long and expensive trials carried out by the author and others who have devoted their time to the subject, but some results are stated without giving sufficient data to enable the average reader to follow the reasoning. The mathematical treatment of the subject is extremely easy to follow, and curves are largely used to represent graphically the results obtained. The book will be of great use as a reference to all tramway engineers, and will be invaluable to electrical engineers commencing traction work.

The first chapter is devoted to the early history of electric motors and to brief explanations of the principles of motor design and testing. Mr. Reckenzaun has adopted the Kapp formulæ in designing, and uses the Kapp unit of induction generally. It is a pity, however, that, having done so, he should, as on page 23, introduce the C.G.S. lines per square centimetre without explaining the relations between the two units.

The second chapter opens with a few considerations of electric transmission of power for other purposes than traction, and a concise description of the Lauffen-Frankfort transmission is given. This is followed by about 50 pages of most useful information on the tractive force required on tramcars and on the fluctuations of power met with in practice. Calculations and curves are given, based on experimental runs on nine different roads under varied conditions. In one case, for example, it was found that an experienced driver used 25 per cent. less power on a given section than a nervous and inexperienced man.

The details of the electrical and mechanical design of motors and their gearing are discussed in the next chapter. Due to what is clearly a slip, the example given of motor design is very misleading. The maximum induction in the armature is stated to be 12 Kapp lines per square inch, and that in the magnets to be 10. In a tramcar motor, where weight is an important factor, 20 and 16 lines respectively are the more usual densities. Of the various gears described, Mr. Reckenzaun appears to commend the single-reduction motor with spring suspension of the field magnets. Speed-regulating devices are fully described, and the evidence given points to the use of subdivided field windings as the most economical method of regulation.

The fourth chapter treats exclusively of the conductors and means of collecting the current. Almost all of the systems of mains which have been tried with any measure of success are described, but special attention is given to the overhead system, 50 pages being devoted to this alone. The question which wire should be earthed, when the earth return is allowed, to reduce the corrosion appears to be doubtful, but where possible a large earth-plate in the station connected to the positive terminal is recommended.

Mr. Reckenzaun next takes up the consideration of storage batteries from the practical point of view, and clearly points out what faults may be expected. He considers that the weight per horse-power hour of accumulators has not been reduced during the last few years.

The sixth chapter consists of a series of descriptions of 12 various electric railways and tramways, examples being given of each of the various distinct systems. In each case the salient features are pointed out, and such details as leakage on the line, the grades and curves of the permanent way, etc., are given to make some comparison to be formed of their relative advantages. The Central London Railway, which is to be constructed on similar lines to the City and South London Railway, is described, and it will

be interesting to compare the estimates given of the power required, and the cost of running, with the actual figures obtained when the line is completed. We are surprised to note the leakage found on the Blackpool line, which is stated to give a mean loss of 7 h.p., and rises to 30 h.p. sometimes when starting. A few particulars are given of the proposed St. Louis and Chicago Railway, on which the speed of 100 miles per hour is to be the normal rate. The general arrangement appears feasible, but we should like to have a few more practical details of the construction.

Chapter VII. is devoted chiefly to the efficiency of electric traction. The author regrets that so few practical tests have been made, but he has collected enough to show the values which may be expected. We see that in two instances the power given to the cars was only 25 and 37 per cent. of the indicated horse-power of the engine. This leaves an ample margin for improvement. In another case, where the regulation was carried out by resistance placed in series with the motor, it was found that 45 per cent. of the power given to the car was wasted in the rheostat.

The last chapter gives the working expenses on a number of well known lines, but the accumulator system is again conspicuous by its absence. The cost of upkeep is in each case dissected carefully and expressed in pence per car mile. The economy of electric traction can be seen from these figures, which will also be of assistance in preparing estimates for new lines. The author has wisely left out the comparison of electric traction with traction by other means, as all such comparisons are necessarily based on the condition of a particular line, and the general conclusions drawn are very apt to be generally misleading.

Altogether, we congratulate Mr. Reckenzaun on the amount of valuable information he has given in the first book on this subject, and trust he will find time to considerably enlarge the second edition, which should soon be demanded. The book has an ample index, and is well illustrated, but we think that titles placed under the illustrations would help the reader. We confidently recommend this volume to all practical men interested in traction work.

INSTITUTES v. JOURNALISM.

BY SYDNEY F. WALKER.

What may be termed the higher education of those who are actually practising any of the branches of engineering is mainly carried on by means of the two channels through which men who are making experience, or who are thinking out different problems connected with the work they have in hand, place the results of their thought and experience before their fellow workers. The papers read before the leading scientific and engineering societies, with the discussions which follow, form a record whose value can hardly be over-estimated. To be a member also of certain institutes, such as the Civil Engineers, and, in a lesser degree, the Mechanical Engineers and the North of England Institute of Mining Engineers, confers a sort of brevet rank which should be worth any number of testimonials, and should enable a man to take a good position in any part of the civilised world. The great care exercised by the councils of these institutes before admitting candidates as members is a far better security for their being masters of their craft than, as was very properly pointed out some years since, any form of registration or examination could possibly afford. Further, the world-wide reputation of these institutes, and the large area over which their *Transactions* are circulated ensure the writers of papers an audience of the very men they want to reach, and often brings them into correspondence with men who may be of considerable service to them in their struggles for success in their profession. But, unfortunately, many of the minor institutes, while imitating the older ones in many of their methods, are too often managed with a total disregard of everyone's convenience and of everyone's interest, except those of the members resident in London, and more particularly of a small knot of men who prac[illegible] rule them.

Institutes live by three things: By subscriptions, by papers, and by discussion. But in the case of many institutes, though they depend very largely for their revenue on provincial members, absolutely nothing is given those members in return beyond the *Transactions* and notices of meetings. The *Transactions* always come to hand months after the paper has been read, and often when all interest in it has passed away, while the members and non-members can read both papers and all that is supposed to be worth printing in the technical press at the time they are issued. The notices of meetings also are often practically worthless. A post card containing two lines to the effect that Mr. So-and-So will read a paper, say, on "Arc Lamps," conveys actually no information at all, unless the member receiving the notice is intimately acquainted with the work Mr. So-and-So has been engaged on. Such a notice is fairly passable for a local debating or naturalists' society, where it is very little trouble to attend the meeting, and where everyone knows what to expect from the member who is to read a paper or from the lecturer who has been engaged. But even the better class of those societies nowadays give considerably more information than is given by the notices quoted above. Usually a brief outline is given, under different headings, enabling those who think of attending the meeting to form a very good idea of what they are to hear. The leading institutes mentioned also give a very full abstract of each paper that is to be read, and will always furnish a proof if requested, or if it is thought that any particular member is specially interested in the subject.

The gravest offender of all the minor institutes in this matter is undoubtedly the Institution of Electrical Engineers. The fact of being a member or associate of the institute is no guarantee that the recipient of the honour is a *bonâ fide* electrical engineer. He may be interested in electrical engineering, say, by holding shares in some electrical company, or by keeping its books. In the management of the Institute, provincial members are altogether ignored. Practically they are told to pay their subscriptions, and accept with becoming gratitude the favours in the shape of the briefest of post-cardial announcements, *Transactions* at uncertain times, and invitations to dinner at very high prices. And the cream of the joke lies in the fact that a non-member can get all these, and be better served than a member. He can buy the *Transactions* at considerably less than the amount of his subscription. He can attend the meetings, if he likes, just as a member can. He can speak at the meetings, and he often does, to the exclusion of members. He can see in the weekly technical press, some days before he would receive his own brief notice were he a member, when meetings are to take place, and the subjects to be discussed. He can dine, too, when members do, if he likes to pay and go with a member friend.

The writer of this article, who has been watching the progress of the Institution of Electrical Engineers for some time past, because he hoped to see it come out of its present subordinate position, and take its place among the leading institutes, was much struck with the following. About a year ago he had occasion to complain of what he considered an act of discourtesy towards him. He was referred to the rules, and that was all that anyone could or would say or do. The idea of a provincial member complaining of discourtesy looked really too ridiculous, though he had belonged to the Institute for 16 years or so. In further reply, the writer gave it as his opinion that if members generally were treated in the same manner, the Institute would go down in numbers. He was told not to be at all afraid of that, as at least 200 new members were being elected annually. Not many months after, a proposal was suddenly made to increase the rate of subscription to new members. In the writer's opinion this was a step backwards. If anything, openings ought to be made to cover everyone who is *bonâ fide* working on some branch of electricity, so that the Institute may acquire the power that comes to any body which can speak in the name of the whole of those following a certain calling. The idea of a member whose own subscription it was not proposed to increase, and a country member, too, raising objections seems to have tickled the Council immensely. However,

there was a complete answer — a financial one. The Institute's revenue was not sufficiently in excess of its expenditure, and there seemed to be no means of retrenchment. Country members had stood a lot, but it might be supposed they would object to being done out of their notices, brief as they were, and of their *Transactions*, late as they come. London members could not be expected to give up anything. One might as well become a country member at once. Of course, this was not told the writer; he surmises it, as the fix seemed such a difficult one. But he ventured, like Oliver Twist, to ask for more information. In his opinion it seemed odd that with an increasing membership, and with country members so persistently ignored, that the proportion of revenue to expenses had declined. However, once more a complete answer was forthcoming. There were so many withdrawals from the Institute that it was absolutely necessary to put the subscription up.

Another thing, too, which struck the writer very forcibly when he attended a meeting some months since was the very large proportion of very young men, of which the audience appeared to be composed. The meeting-room was filled, but the men of full years, say, 30 and over, who were present were in a very decided minority. The Institute has also brought considerable ridicule on itself and has lost caste by the tone of its discussions. Striking personalities even find their way into the *Transactions*. Many speeches that are made are nothing more than advertisements of certain firms or certain companies. But the point the writer wishes to bring out, as forcibly as he knows how, is the fact that all which the minor institutes ought to do, and could do if properly managed, is being done far better, at considerably less cost and with profit to themselves, by the technical journals. The institutes dare not withhold their *Transactions* from these journals if they could. In fact, the favour, if any, is on the other side. To have their papers reproduced is to advertise themselves, that they are still alive, as nothing else can. And yet these papers produce, not only all the *Transactions*, but other articles upon important subjects, and valuable information in addition. And further, their columns are open to everyone who is interested in the science and can write intelligently.

It is well known that electric engineering will be *the* branch of engineering of the future *par excellence*; that it already threatens to eat up its older brethren, as Pharaoh's lean kine did; and that every year brings increased possibilities and a larger field. Surely, it is not too much to ask that those who are guiding the Institute which should be representative of the whole body of electrical industry should rise to their position, and should prepare to lead towards the great future we are all hoping for.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

III.—WORK AND HORSE-POWER.

(Continued from page 401.)

GAS AND OIL ENGINES.

Those who visited the Electrical Exhibition held at the Crystal Palace during the first half of 1892 and who inspected the Machinery Department, must have been surprised to see the great number of gas engines that were at work—gas engines of all sorts and conditions. There probably has never been such a display of gas engines of various types (more than a dozen) before; at all events, not in England.

The advent of the gas engine could not have occurred at a more opportune time than in conjunction with the advent of electric lighting; the one has to great extent furtheranced the adoption of the other, and *vice versâ*. The private electric light installations, such as in country houses, hotels, etc., called for a reliable source of small power which could be drawn upon at five minutes' notice, and did not necessitate constant individual attention. This want was supplied by the gas engine. On the other hand, it is safe to say that the adoption of electric lighting has been the means of considerably widening the field in which this kind of motive power can be used with advantage. The great number of gas engines of various types now invented is due to the expiry of patent rights in England of the fundamental principle of Otto's cycle, hitherto held by Messrs. Crossley Bros., and which expired in the summer of 1890. The idea of obtaining motive power by igniting explosive gases dates back to the seventeenth century, when Robert Street, in 1794, was the first to make a practical gas engine having a cylinder and a piston. After this, numerous attempts and inventions were made to produce a gas engine that would be of practical and commercial value. But it was not until the year 1876 that the internal-combustion engine assumed a shape that made it at once a reliable source of motive power and a sound commercial success. This important improvement was made by Dr. Otto, whose name is now famous all over the world. The manufacture of these engines was taken up in England by Messrs. Crossley Bros., of Manchester, who have made great improvements in detail and mechanical construction.

The Otto Cycle.—The method in which Dr. Otto uses the gas, and the operations that take place in the cylinder of the engine, is known as Otto's "cycle of operations," and in order to understand how a gas engine works, it is necessary to know what the "cycle" is. The cycle of operations consists of four distinct operations. We will imagine the piston at the top end of the cylinder ready to make its forward stroke. Upon moving forward, the admission valve is opened, and a mixture of coal gas and air is drawn into the cylinder after the piston. When the piston reaches the bottom of the cylinder the admission valve is closed, the whole of the cylinder space in front of the piston being now occupied by a gaseous mixture. Upon the piston making its return stroke it drives all this mixture in front of it, and as it cannot escape it is compressed, so that by the time the piston has reached the end of its stroke the gas exists under great pressure. These two strokes of the piston, one forward and one return, constitute one complete revolution of the flywheel. The third operation now takes place—that is, the ignition valve is opened, and the mixture fired. The explosive force gives an impetus to the piston, which consequently travels forward upon arriving at the end of its stroke. The impetus given to the flywheel tends to carry it round past the dead centre, therefore the piston is urged to make the return stroke. At the moment of returning, the exhaust-valve is opened, and so the fourth operation consists of the piston driving out before it all exploded mixture, which now escapes by the exhaust port. Upon arriving at the end of its return stroke the admission valve is again opened, ready to admit a fresh charge of gas and air, and so the first operation is ready to be repeated. These four operations constitute a complete cycle, and can be stated thus:

A. Admission of gaseous mixture.
B. Compression " "
C. Expansion " "
D. Exhaustion " "

The cycle produces two complete revolutions, so that an explosion takes place and an impulse is given to the piston once every two revolutions, or during every alternate forward stroke of the piston.

Combustion in the Cylinder.—When a gaseous mixture explodes, it means that the gases burn with very great rapidity, so that explosion signifies rapid combustion.

The intensity or force of an explosion depends on a number of circumstances, such as the composition and nature of the gases, their pressure, etc. The duration of an explosion is the time that elapses between ignition and the maximum pressure produced. The shorter this time is the more powerful and effective is the explosion. Further, this maximum pressure occurs, and therefore the explosive character ceases, when one-half of the total heat of combustion has been evolved. A rich gaseous mixture explodes more rapidly than a poor mixture. After ignition the whole of the heat of combustion is not evolved at once, but takes place gradually, combustion taking place more slowly the nearer the end is reached; for if this were not so, the shock would be so great that enormous pressure and strain would

be put upon the mechanism of the engine. Combustion and evolution of heat thus goes on throughout the whole length of the piston stroke. By making the combustion gradual in this manner, a more even and steady pressure is given to the piston. An explosion every revolution gives a more steady-running machine than one in every other revolution.

Efficiencies.—The power and efficiency of a perfect heat engine can be measured by the absolute temperatures between which it works. When mechanical energy is produced from heat energy, it must always be accompanied by the annihilation or disappearance of an equivalent amount of heat energy, and this is shown by the fall of temperature which takes place in the heat-producing body. The higher and lower temperatures between which the fall occurs are called the "limiting temperatures," and the greater the difference between them the greater is the power produced. From this it is clear that when a body does work it must lose heat or fall in temperature, just as a body of water, in order to do work, must fall from a higher to a lower level, or a current of electricity from a higher to a lower potential. The limiting temperatures indicate the "efficiency" of the perfect heat engine, and the greater the difference of temperatures the greater the efficiency. Take the case of an ideal steam engine, where the temperature of the steam on entering the cylinder is, say, 200deg. C., and on leaving is 50deg. C. The fall in the temperature measures the work that is done on the piston. First, however, the temperatures must be reduced to absolute temperature. Absolute temperature is – 273deg. C.—that is to say, a body at that temperature is supposed to have so little heat that it is fixed theoretically as zero; so that a body at the ordinary temperature of 0deg. C. is really at 273deg. C. absolutely.

The limiting temperatures absolutely are then (200 + 273) – (50 + 273) or 473 – 323.

Let the higher temperature be T,
" lower " t,

then the efficiency of any heat engine working between these two limiting temperatures can be calculated by the general formula—

$$\frac{T - t}{T} = \text{efficiency.}$$

Applying this particular example, we have—

$$\frac{473 - 323}{473} = \text{efficiency} = \cdot 31.$$

Hence an engine working between these temperatures can only utilise about one-third of the heat supplied to it, and this is the utmost efficiency, theoretically, that can be got out of it, judging it an ideal or perfect engine.

The steam engine in use to-day is very far from being perfect, and heat is wasted to a great extent, as the best made can only utilise 20 per cent., and if judged from the coal consumed the total efficiency is only 10 per cent., since 50 per cent. is lost in the boiler.

In a gas engine the cylinder is the furnace of the engine, and the fuel and the motive force are one and the same, whereas in the boiler the fuel is coal and the motive force steam.

According to Prof. Robinson, in his authoritative work on "Internal-Combustion Engines," the temperature of the exploding gases in the cylinder of a gas engine can be taken at about 1,600deg. C. just after the moment of ignition, although it is very difficult to find out what is really going on inside the cylinder, there being so many disturbing elements to contend with. As the gases burn and expand, the temperature falls, until just at the end of the stroke, when they are leaving the exhaust port, the temperature is about 400deg. C. This gives an ideal efficiency of

$$\frac{1{,}873 - 673}{1{,}873} = \frac{1{,}200}{1{,}873} = \cdot 64.$$

Like the steam engine, a great amount of this heat is lost in practice; the exhaust gases carry off nearly one half of the total heat available, while the water-jacket carries off another quarter. The following proportions are given by Prof. Robinson as to the probable way the heat is distributed:

Heat utilised by piston	23 per cent.
" carried off by exhaust	27 " "
" " " water jacket ...	50 " "
Total heat of combustion =	100

Comparing the total efficiency of the steam engine with that of the gas engine, a steam engine utilises, say, 10 per cent. of the heat evolved by the coal; a gas engine utilises, say, 20 per cent. of the heat evolved by the coal gas. So that a gas engine is twice as efficient as the steam engine. A very good steam engine uses, say, 2lb. of coal per brake horse-power hour, this being the utmost efficiency practicable; 1lb. of coal, when burnt, will evolve 14,500 heat units; 2lb. = 29,000 units. In a large-sized gas engine it may be taken that the consumption of gas per brake horse-power per hour is 22·5 cubic feet; 30 cubic feet of gas weigh 1lb., and evolves 20,000 heat units, 22·5 cubic feet of gas weigh ·75lb., and evolves 15,000 heat units. Therefore the gas engine only requires 15,000 heat units to produce 1 b.h.p., whilst the steam engine requires 29,000, or close on double.

The efficiency of the mechanism of a gas engine—that is, the ratio of the indicated horse-power to the brake horse-power—is high, and about similar to that of a steam engine. On an average it may be put down that the brake horse-power is 85 per cent. of the indicated horse-power or that 15 per cent. is lost in friction of the moving parts, etc. One pound of good anthracite coal will yield about 4·5 cubic feet of coal gas, so that in fairly large engines the consumption of coal per brake horse-power per hour is, say, $\frac{22 \cdot 5}{4 \cdot 5} = 5\text{lb.}$

The heat energy obtained from burning the gas obtained from 1lb. of coal is therefore $\frac{20{,}000}{30} \times 4 \cdot 5 = 3{,}000$ heat units, or only one-fifth of the heat energy obtained by burning the coal.

The Water-Jacket.—The great temperature attained by the exploding gases, about 1,600deg. C., and the great amount of heat that is absorbed by the walls of the cylinder, would have a most injurious effect on the cylinder, causing overheating, expansion, etc., and preventing lubrication, etc., unless it were protected in some way for the purpose. The cylinder is enclosed in a water jacket, somewhat like a steam-jacket round the cylinder of a steam engine; through this water-jacket a current of cold water is caused to circulate. To obtain a continual circulation of water a capacious tank is fixed as close as convenient to the engine, and at a level of, say, 6ft. above the floor. A pipe leads from this tank into the bottom of the water-jacket, and another pipe leaves the top of the water-jacket and returns to the water-tank. The water has thus a free passage round the walls of the cylinder, the great heat from which raises the temperature of the circulating water. The circulation is produced by the water leaving the jacket hotter than it enters it. In general, the water leaving the jacket ranges from 40deg. C. to 60deg. C., according to the type of engine, and the water entering should be a little above the temperature of the atmosphere. A suitable tank is always fixed up by the supplier of the engine.

Consumption of Gas.—It may be taken that a medium sized gas engine—say, 14 b.h.p.—will consume about 25 cubic feet per brake horse-power per hour, working at full load, when the gas is supplied at a good pressure, and is of a good quality. In districts where the gas is poor in its heat-giving properties and below the proper pressure the consumption will be greater. This is often the case in country districts or about small towns. The consumption of gas in a gas engine may be taken to vary inversely as the power of the engine. Taking a 14 b.h.p. as a medium and standard, we may put down 25 cubic feet per brake horse-power per hour at full load. Now as the power rises so the consumption of gas falls, and as the power falls so the consumption rises. The following tabulation will serve as a guide, although the figures given are only approximate, and may be slightly

higher or lower, according to the type of gas engine used, no particular gas engine being specified.

TABULATION III.

Brake horse-power	3	6	9	[illegible]	22	35	72
Cubic feet per b.h.p. per hour..	37	[illegible]	27	25	22	20	17

It is not advisable to work a gas engine up to its utmost power unless circumstances demand it; a fair margin should always be allowed. This is particularly so when it is working electric lights, because if an explosion is missed, as often happens, the engine becomes overloaded, and tends to pull up, and very often it must be eased before it can recover itself. Lately, gas engines of very large power have been put on the market, and with great success, sizes of 200 i.h.p. being manufactured. Engines of above 80 i.h.p. or about that power are made with twin cylinders. The very small sizes, say from 1 b.h.p. to 6 b.h.p. are made both vertical and horizontal, the vertical design being very useful where floor space is limited.

Advantages of the Gas Engine.—Gas engines are greatly in demand where small motive power is required, and their advantages on this score are not to be denied. They can be put down anywhere where a supply of gas is to be had, can be started in 10 minutes, stopped in one minute, and require very little attention—very different from the constant watching which a boiler and steam engine necessitate; no flue or chimney shaft has to be built, and the engine, having its furnace in its cylinder, occasions no dirt or trouble in keeping in order. It is not necessary to have a man on purpose to run a gas engine, except very large sizes, or where the plant is one of great importance, say in a theatre, etc., where great, if not serious, inconvenience would occur to the public in the event of anything going wrong. In country houses where they run an electric plant by a gas engine, the plant is usually placed under the care of the gardener or other ground man, and who only needs to look in every hour to oil up and see that everything is right; in a number of places the lights are run from accumulators or storage batteries, the gas engine running only during the day time to charge them with the dynamo, the lights being disconnected. Special oiling arrangements can be supplied with these engines for this kind of work, so that they can be run for 10 or 12 hours without attention.

Running Cost of Gas Engines.—An investigation will now be made respecting the probable cost of running a gas engine; one of 35 b.h.p. will be chosen, so that it will be about the same size as the 40-b.h.p. steam engine, whose cost was given on page 401, the maintenance cost being divided up in the same way as with the steam engine. A comparison of costs between gas and steam power can thus be made. The outlay for a gas engine yielding about 35 b.h.p., including foundations, water-tank, pipes, and fixing in working order, may be put down at £280. The running cost will be divided into two parts, as was done when estimating the running cost of a steam plant.

Therefore we have

Large Gas Engine of 35 b.h.p.

A.—INVARIABLE COSTS.

	B.H.P. per annum.	B.H.P. per hour.
Interest on outlay, £280 at 4 %	£0 6 4	·025 penny.
Depreciation ,, ,, 7½%	0 12 0	·048 ,,
Repairs ,, ,, 5%	0 4 8	·018 ,,
Attendance, two hours' time per day	0 8 7	·034 ,,
Total	£1 11 7	·125 penny.

B.—VARIABLE COSTS.

20 cubic feet of gas per hour for 3,000 hours, gas being 2s. 9d. per 1,000 cubic feet	£8 5 0	·66 penny
Oil, water, waste, and sundries	1 0 0	·08 ,,
Total	9 5 0	·74 penny

Giving total cost per brake horse-power per annum = £10. 16s. 7d
And ,, ,, ,, ,, hour = ·865 penny

As with the steam engine, let the gas engine only work for 1,500 hours per annum; when used for running electric lights from dusk to 10 p.m., another comparison can then be obtained respecting running costs, the working hours in this latter case being only half the former. The first part (A) of the cost will remain constant, while the second part (B) will vary in proportion; since 1,500 is half of 3,000, therefore the variable costs will be £9. 5s. ÷ 2 = £4 12 6
and the total will be £4. 12s. 6d. + £1. 11s. 7d. = 6 4 1
Giving the cost of 1 b.h.p. per annum .... = 6 4 1
,, ,, ,, ,, ,, hour............ = 0 0 1

Following up the comparison of cost of gas *versus* steam, we will now work out the probable cost of a 9-b.h.p. gas engine, this small size being taken to compare with the 10-b.h.p. steam engine, allowance being made for the lower efficiency, as was done with the small steam plant. The outlay for a 9-b.h.p. gas engine, high speed, and designed for electric light plant, may be put down at £160, everything complete. The running costs being as follows, the engine working 3,000 hours per annum:

Small Gas Engine of 9 b.h.p.

A.—INVARIABLE COSTS.

	B.H.P. per annum.	B.H.P. per hour.
Interest on outlay, £160 at 4 %	£0 14 3	·057 penny.
Depreciation ,, ,, 7½%	1 6 8	·100 ,,
Repairs ,, ,, 3 %	0 10 8	·043 ,,
Attendance, two hours per day	1 13 4	·133 ,,
Total	£4 4 11	·333 penny.

B.—VARIABLE COSTS.

27 cubic feet of gas per hour for 3,000 hours, gas being 2s. 9d. per 1,000 cubic feet	£11 2 9	·890 penny.
Oil, water, waste, and sundries......	1 5 0	·100 ,,
Total....	£12 7 9	·990 penny.

So that total cost per brake horse-power per annum = £16 12s. 8d.
And ,, ,, ,, ,, ,, hour = 1·33 pence.

This is just over 50 per cent., or half as much again as the cost per brake horse-power of the large gas engine; or by spending two and one-half times as much per annum for the large plant, four times the power can be obtained, since 40 × £10 = £400, and 10 × £16 = £160.

Letting the small gas plant run for 1,500 hours per annum, the figures work out as follows: We have £4. 4s. 11d., which remains constant, and £12. 7s. 9d., which must be divided by 2, because the value of B are in proportion to the hours. So the total costs will be £4. 4s. 11d. + £12. 7s. 9d. ÷ 2, or £4. 4s. 11d. + £6. 3s. 11d. = £10. 8s. 10s. per brake horse-power per annum, or ·4 penny per brake horse-power per hour.

When motive power is required for running electric lights on business premises, the time from dusk to 10 p.m. (which is 1,456 hours per annum including Sundays, and 1,248 hours per annum excluding Sundays), is in most cases too long, and calculations for much shorter hours might be acceptable. From dusk to 8 p.m., including Sundays, means about 742 hours per annum, or 636, excluding Sundays, and from dusk to 8.30 p.m., excluding Sundays, signifies close on 786 hours per annum. Taking half of 1,500, we have 750, and this number of hours will be near enough to judge of the cost of running from dusk to 8.30 p.m., excluding Sundays.

The results are as follows, 750 hours running:

Large steam plant per b.h.p. .. ... =	£6 5 0 per annum, and =	2·00d. per hour.
Small steam plant per b.h.p. ...... =	14 17 3 per annum, and =	4·75d. per hour.
Large gas plant per b.h.p. . ..=	3 17 10 per annum, and =	1·24d. per hour.
Small gas plant per b.h.p. ...... =	7 6 10 per annum, and =	2·35d. per hour.

(To be continued.)

Prescot and Knowsley.—The cable for the electric lighting of Prescot and Knowsley Hall has now been completed by the Insulated Wire Company, of Prescot. The generating plant is situated at Prescot. The mains to Knowsley Hall, over three miles distant, are concentric. There are two of these mains, each capable of supplying 1,000 lights, so that if any repairs are wanted on one main the supply will not be interrupted. With regard to Prescot it is proposed to place 12 arc lamps in prominent positions in the town, and these can be supplemented when required by incandescent lamps. A ring of three mains surrounds the town, one being for private supplies, the other for public lighting, and another for shops and factories. The Prescot Watch Factory is to be lighted with 1,500 lights, and other arrangements are in negotiation for the lighting of various residences in the district. The work has been carried out under the direction of Mr. S. V. Clirehugh, engineer to the company.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.*

BY PROF. GEORGE FORBES.

LECTURE IV.

(Continued from page 411.)

Now, as an example, I will mention the case of the city of Edinburgh. There it is possible to use the heights which surround the town for collecting the water. In the immediate vicinity of that town there is the hill known as Arthur's Seat, at a height of 800ft. above the sea. There is on this hill a loch already, called Dunsapie, which holds water enough to supply 1,000 h.p. for two hours. Anyone who is conversant enough with central station work will see that here there is the means of supplying sufficient power for doing the work of a large central station—in fact, driving one central station by means of the water power which could be derived from that reservoir; but with the utmost facility a dam can be built across a gully which there is near the summit of the hill, giving us a far greater height, and this dam would cost but little, owing to the natural construction of the hill; it would be invisible from all parts surrounding Edinburgh, save only in one direction, and even in that it would not be on the sky line, and would not be an injurious feature in the landscape, whilst to those who go up to the summit to enjoy the view, the lake which would be formed would be an extra attraction. There is really nothing in the beautiful features of the place to prevent that being done, and thus the amount of power which could be stored would be fully doubled. For working a station which requires the maximum of, say, 1,000 h.p., we do not require an average in many cases of more than about 150 h.p. What, then, we should have in this station would be engines and boilers for 150 h.p. continually working day and night, from week's end to week's end, employed in pumping water up through pipes to this reservoir on Arthur's Seat. In connection with these pipes, at or near their lowest part we should have turbines driving dynamo machines, for the distribution through the town. Instead of being obliged to have engines and boilers of 1,000 h.p. we should have them of only 150, thus saving an enormous amount in capital expenditure. If we do not require to build a dam, as we do not in the first instance, using the Loch Dunsapie which is there, the only serious item to consider, to be put against the boilers, is the pipes. These would come to something like £2,000, but the saving in capital expenditure on the whole is very great. But it is not only the saving of capital expenditure which is important; it is the annual saving in the coal bill. The pumping up of this water by an engine perfectly continuously can be done in the most economical manner that any work with steam engines can be done; whereas, on the contrary, we know that in central station work for electric lighting we have one of the most uneconomical methods of using coal possible. We can get 1 h.p. available on the turbines, including the losses in pumping up and the losses in the turbines, for certainly very little over 3lb. of coal per horse power per hour used in the boilers; whereas, in many central stations, as you know, they are going up to 10lb., 15lb., or even more of coal per horse-power per hour. There is then undoubtedly a most enormous saving in fuel besides the saving in capital expenditure, and for these reasons, wherever such a system is available, it will be desirable to adopt it rather than to put down the whole plant necessary for generating the maximum current which may ever be required. I worked out this pretty fully in the case of Edinburgh for my own satisfaction, and have already brought the matter before the authorities there, and I hope to see some such scheme adopted, not only there but in many other towns also where equal advantages are offered. In working out the figures I may say that the actual expenditure is very little more than half what it would be if we were putting down steam plant for the whole work, and the savings which are effected in attendance and fuel are, even when we are using coal for generating steam, very great indeed. It saves about one third of the expense, not including of course the expense of distribution of electricity, and so forth.

* Cantor Lectures delivered before the Society of Arts.

If I had to be contented with simply what I have told you up to the present moment, such a scheme would be of the utmost value in cases where it is applicable, but there is another source of economy which can be introduced, and for which this system which I have advocated is perfectly suitable. This leads me to the part of the subject to which I wish to draw your attention this evening, and that is the employment of destructors for utilising the refuse in towns—the ashbin refuse, which at present costs an enormous sum of money to be got rid of, and which, in many towns, is simply tipped in the outskirts, and becomes a source of disease and danger especially when the town expands, and building operations commence in the region which has been used as a tipping ground. The whole question of the disposal of town refuse is one of importance. It is one to which, I need hardly say, electrical engineers, as a general rule, have not paid much attention. I daresay there are comparatively few here who have really gone into the question of the use of destructors, and I should not be surprised if there are some present who have hitherto been ignorant of what a destructor was; in fact, a very well-known electrician last week, after I announced that I was going to speak about destructors, and the considerable importance that I attached to them, came and asked me, after the lecture, what it was I was going to talk about.

Several years ago, when I was advising the Vestry of Paddington about the electric lighting of their parish, I found that they were in a serious difficulty in dealing with their ashbin refuse, and I was led immediately to see the importance of studying the whole question. I then made a personal inspection of most of the destructors which were then in use, and I was so enormously impressed with the importance of the subject that ever since then I have neglected no opportunity of seeing the work which is being done in this direction in the different towns.

Let us see what the problem was that Paddington had to face. Every year they collected something like 20,000 tons of refuse of this character, and since the population of Paddington is 112,000, we may assume generally that something like this proportion exists in nearly all towns. It so happens that the proportion of ashbin refuse to population does not vary very much with the different towns. Now, it will strike you, as it has struck me as a very wise provision of Nature, when I tell you that if this refuse were properly burned, and if it were used in the most economical way, it would be found that (assuming the proportion of lighting required for such population to be, as has been very generally assumed, one lamp per head) the amount of refuse provided by any population is almost exactly as much as is required to supply the illumination by means of the electric light to that same population.

Now let us see what this refuse is which is collected every year in Paddington. Out of every 10,000 tons we find that ashes constitute 5,260 tons, breeze or cinders 2,880, what is known as soft core—viz., animal and vegetable refuse—1,420, hard core, which is pottery and that sort of stuff, 290, actual coal 15 tons, bones 25 tons, rags 42 tons, iron 35 tons, brass and pewter 3 tons, white glass 7 tons, and black glass 23 tons. These are the materials that have to be got rid of. I have given you these figures as I found them at Paddington, because Paddington is more able to give accurate information on the subject than almost any place I know of, because in Paddington, instead of simply taking away the refuse and dumping it somewhere or other, as is done in many towns, they found it was more economical to sort out the different materials in this way, and sell some of them for different purposes. They were able to get a sort of price for a great many things. Coal always had its use, and breeze and ashes could be sent to the brickfields, and they were able to recoup themselves to a certain extent, so that really the actual cost of getting rid of it in the parish of Paddington was only about £1,000 per annum. In other places it is very much more, but in any case the manner of getting rid of it was bad. There was a large proportion of stuff which could not properly be rendered harmless, but which had to be disposed of in some way. The quality of the refuse varies with the different towns. For example, in this you see there is no sludge of the streets, and no other objectionable

matter which may be found in other places. In Manchester, for example, out of 10,000 tons there are 6,450 tons of ashes and excreta, which are collected in pails, dust and cinders 3,455 tons, fish and bones 15 tons, dogs, cats, hens, rabbits, etc., 5 tons, boots, rags, hats, paper, etc., 5 tons, vegetable refuse 5 tons, glass, pottery, bricks, etc., 60 tons, old iron and tinware 5 tons. That makes the 10,000 tons. In addition to that, they have to dispose of slaughter house refuse and market refuse, and street sweepings, amounting to 2,900 tons, in addition to every 10,000. The aggregate quantity of burnable material is 70,000 tons. It is found that the quantity of coal which is collected in the ashpit refuse varies with different times of the year, and with different districts. It is more in the richer residential districts, and it is also more in winter. In summer there is more vegetable stuff, which is less combustible, and there are some places in which the ashes are exposed to the rain, in which case the combustibility is affected. But then see another wise provision of Nature—the coal and cinders are more frequent in winter, when we want most light, and vegetables are less frequent then, and they are less combustible materials.

The history of the use of destructors is comparatively modern, and the very first ones that were attempted were not very successful. The cause of their failure was almost altogether due to insufficient draught, and in almost all cases where a great improvement has been made in them, it has been by the introduction of greater draught. In the first destructors the furnace was fed from the front, just as the ordinary furnace of a boiler is, but that has been completely done away with now. During the last 20 years, one type of destructor has been most generally used—that is, the type known as Fryer's destructor—which has been made by Messrs. Manlove, Alliott, and Co., of which I shall have more to say later on.

Fig. 1.

The first destructors which were put up on any scale were in Water-street, Manchester. Eight furnaces were put up, and these were the first that were any practical success. They consumed 28½ tons each per week of 5½ days. They were 8ft. 6in. by 4ft. 3in. wide, and 6ft. 3in. high from the firebars up to the crown of the arch; 5ft. of the length was occupied by firebars, and 3ft. with the hearth. There was a bridge at the back, and a descending flue down into the main flue for carrying off the gases.

The next place that was furnished with destructors was the Montague-street Wharf, Birmingham. These destructors have been in use for a long time, but they have been combined with the process employed there of converting excreta into profitable manure for agriculturists, and consequently the efficiency of the destructors has been considerably impaired. It was necessary there to keep up steam for the treatment of the excreta, and steam was got up from these furnaces by putting the boilers directly over the furnace. In consequence of this, the combustion is very imperfect. The large cooling surface of the boilers impedes the combustion in an effectual degree. In most cases where boilers have been used to generate some steam, the boilers have been put away, and after the gases have passed through the flue they then pass by the boiler, and the error has been in the opposite direction. At Birmingham the fault is placing the boilers on the furnace, so that there is no proper combustion; in many other places, take Southampton, for example, as a notable case, the boilers are put in a place where they cannot benefit from the maximum heat.

After these destructors had been introduced, the Fryer destructor came into more general use. Fig. 1 shows this destructor. The furnaces there are 9ft. long, 5ft. wide, and covered by a firebrick arch 3ft. 6in. high. The furnace has an inclination of 1 in 3, 4ft. of the bottom being a firebrick hearth, and the other 5ft. of firebars. The furnaces are arranged in two long rows, back to back, with a large flue underneath and between the rows, as shown in section in the diagram; and the air is admitted beneath the firebars. At its upper end the furnace is divided in two longitudinally by a short vertical wall. On one side of this division the hearth is inclined at a greater angle than the rest, as shown in the left-hand furnace on the diagram, and immediately over this is the opening through which the refuse is shovelled down, after being tipped over on the top from the carts which carry it, the hole being shown covered by a flat cover. On the other side of the dividing wall is the opening to a flue leading from the furnace to the main flue, as shown in the right-hand furnace on the diagram. Each furnace then has two outlets at its upper end, side by side, through one of which the refuse is fed from above; the other forming the exit through which the products of combustion pass to the main flue. Besides these there is, in a few of the furnaces, another hole right over the hottest part of the furnace (shown in the left-hand furnace on the diagram), which is generally covered, but can be opened when required. This hole is usually called the mattress-hole, and is used for putting in infected bedding and other material, such as carcases and other slaughter-house refuse, and other such like matters which have to be utterly destroyed. The main flue is sometimes made extremely large, so as to allow dust to settle, and baffles are sometimes introduced into it to increase the facility of the dust settling. Sometimes at the end of the flue there is a very large chamber put for the same purpose, through which the gases pass before entering the chimney. These are the chief points in connection with the Fryer destructor.

One of the chief defects of this destructor is that it is possible for the air which is admitted to blow towards the flue and carry half burnt stuff down into the flue. But the danger is not only from half-burnt stuff being carried down, but there is also another serious point—viz., that the fuel which is at the upper end of the furnace is, of course, being heated up by the flames in the furnace, and consequently giving off injurious and most objectionable gases at that comparatively low temperature, and instead of being burnt in the furnace they may be carried over into the flue immediately with the utmost facility, and become a source of great annoyance to the neighbourhood. In such a type of destructor there are always cases where objectionable and offensive fumes are perceptible, and not only objectionable smells, but unburnt material, consisting generally of a kind of scaly, shiny slag, in minute filaments, is seen to fall in the neighbourhood of the destructor, because this type of furnace does not allow of its being thoroughly burnt. I need hardly say that the higher the temperature in a furnace the better is the destruction of material, and not only is it desirable to have a high temperature, but also to have all the gas passing over that part of the furnace which has the highest temperature. I might give a considerable amount of further instruction from the study of many destructors which have been put up, but I will only mention one appliance which has been built to several destructors, and that is what is called a cremator. It was first introduced by Mr. Chas. Jones at Ealing. It consists of a furnace, in which coal is generally used, and over this furnace all the gases are passed before they go to the chimney, in order to burn the organic matter of the gases which have been allowed to pass through the furnace. I can only say about cremators—although I have seen a great many built—that they are very seldom to be seen at work except when there is a deputation coming to examine them, because the cost of working them is far too great.* If anything in the shape of a cremator were to be used at all, I would suggest that the gases ought to be passed a second time through the furnace, from under the firebars.

* Mr. Jones informs us that this is not true at Ealing, that the cremator at Ealing has been burning night and day for seven years, except, perhaps, a fortnight in the year for repairs; and that the additional cost is quite immaterial.

Since there is 80 per cent. of air in the gases that come out of the chimney, it is perfectly clear that we could get good combustion in a furnace, if those gases were fed under it.

(*To be continued.*)

TRADE NOTES AND NOVELTIES.

TEMPERED COPPER.

As copper in its various forms constitutes a vital material of all electric apparatus, and especially that of dynamo-electric machinery, all improvements relating to the manipulation of copper may well claim a prominent position of interest to elec-

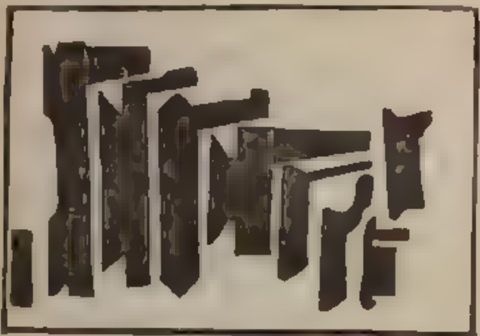

Fig. 1.

trical engineers. The solution of the problem of discovering a process by which the life of this important metal could be prolonged, has much occupied the time of investigators. Mr. Alner Thomas's investigations led him, first, to a method of casting pure copper without alloys of any kind, and free from blow-holes; and, second, to a method by which the copper so cast can be hardened sufficiently for all mechanical uses, and imparted a strength equal to that of ordinary steel, or, if desired, made as malleable as wrought iron, and capable of being welded or forged into any desired shape by any blacksmith. A company was formed, and Mr. G. Berend, of 61, Fore-street, has been appointed representative here. The company devoted a great deal of their attention and a large part of their works entirely to the manufacture of commutator segments and brushes; for in spite of the many attempts which have been made to supersede the employment of copper subjected to wear in electrical apparatus, the fact remains that at the present time no real substitute is available. Their metal, the Eureka Tempered Copper Company claim, combines these peculiar qualities which enables the commutator bar to withstand the action to which all surfaces transmitting heavy electric currents are subjected.

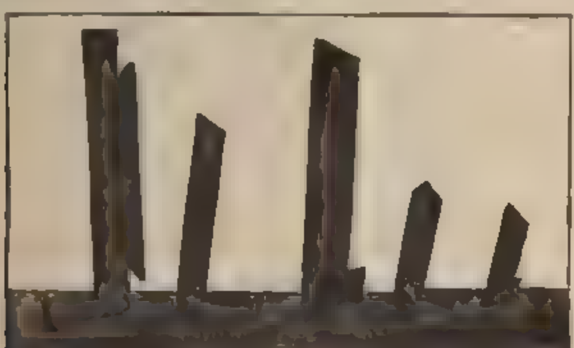

Fig. 2.

In Figs. 1 and 2 are illustrated a variety of commutator segments employed in various types of machines. Fig. 3 shows two well-known types of commutators, that to the left being the usual type employed with the Gramme and Siemens type of armature, and that to the right a Brush commutator. But there are still more important surfaces subject to wear on the dynamo—namely, the brushes, and in this direction also the metal has been used. Fig. 4 shows various types of brushes, from those with fine slits, up to the type embodying almost a solid construction, adapted to various types of machines. These brushes partake of the same nature as the commutator segments, in their wearing qualities, in toughness, as well as their conductivity.

The large wear met with in some of the practical details of electric railway work has also developed several important applications for tempered copper. Among these we may mention its employment in the gears employed to transmit the power from the motor to the car axle, and also for trolley wheels to take the current from the overhead wheel; its peculiar toughness gives it not only a long life, but the anomalous structure of tempered copper largely reduces the noise, which is so noticeable and disagreeable a feature in steel pinions. In the case of the Eureka tempered copper trolley wheels, its wearing qualities have also largely reduced the difficulties encountered by this necessary adjunct to electric railway work. Numerous tests have shown tempered copper to consist of copper 99·981 per cent. pure, with a tensile strength of 64,000lb. per square inch, and a compression strength of 189,000lb. to the square inch. A test made a short time ago by the Austrian Government Industrial Department at Vienna showed a higher tensile strength than many of the steels which had been tested there. Wire made from tempered copper is being largely used for all purposes where great strength is desired, and its purity renders its conductivity far greater than that of copper alloys. Its use for telegraphy and telephony, especially long-distance telephony, in the States is rapidly increasing.

Fig. 3.

The chemical analysis which has been made by Dr. F. A. Genth, of Philadelphia, of tempered copper in various forms, confirms that it is pure copper without alloy, and that no chemicals are added in the process of tempering.

	Tempered Copper. Pig copper. Per cent.	Tempered Copper. Edge pieces. Per cent.	Tempered Copper. Castings. Per cent.	A Not tempered. Per cent.	B. Tempered. Per cent.
Silver	0·096 ...	0·053	0·095	0·026	[illegible]
Copper	99·880	99·861	99·914	99·930	[illegible]
Tin	traces	0·045	0·064		
Lead	traces	traces	traces	—	
Iron	0·056 ...	0·069 ...	0·056 ...	0·083 ...	[illegible]
Aluminium	...	—	6·665		
Zinc	—	—			
Arsenic	—		—	0·046	[illegible]
Phosphor	—		—	0·017	[illegible]
	100·042 ...	100·128 ...	100·169 ...	100·101 ...	100·1[illegible]

The last two analyses were made from the same bar, A, not tempered, being made from the bar cast by the process of

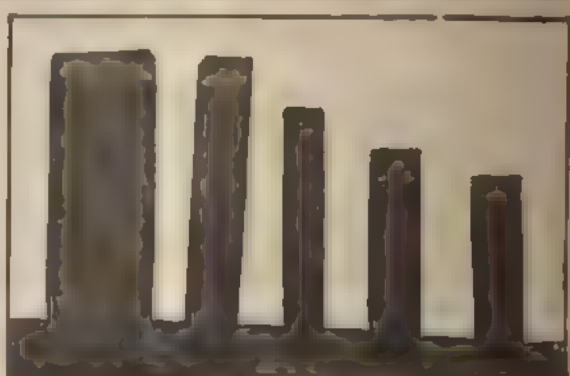

Fig. 4.

the Eureka Company, but untempered; and B, tempered, being made after that bar had been tempered.

NEW COMPANIES REGISTERED.

Elieson Accumulator (British Patent) Syndicate, Limited.—Registered by Arnold Cunliffe, 6, Great Winchester-street, E.C., with a capital of £12,000 in £1 shares. Object: To acquire from C. P. Elieson certain patent rights relating to improvements in electric accumulation, in accordance with an agreement, particulars of which are not given; generally, to carry on business as manufacturers of and dealers in electrical apparatus and apparatus of every description. There shall not be less than three nor more than seven directors, the first being the first signatories to the memorandum of association. Qualification, £100. Remuneration to be fixed in general meeting.

BUSINESS NOTES.

Portsmouth.—The foundation-stone of the central station was laid yesterday.

Glasgow.—Electric light has been introduced into the large warehouse of Messrs. Wylie and Lochhead, in Buchannen-street, Glasgow.

South Africa. — Electrical pumping machinery has been ordered for the Durban-Roodepoort and Main Reef Companies' properties.

Fiume.—The authorities of Fiume, Italy, invite tenders for the construction and working of an electric tramway for passengers and goods.

Electric Heaters.—A system of electric heaters specially adapted for conservatories is being brought out by the firm of Olivet et Cie., Geneva.

Aberystwith.—The experiment with electric lighting for the Aberystwith Corporation has been satisfactorily carried out by Messrs. A. Hall and Co., of Liverpool.

West India and Panama Telegraph Company.—A dividend of 6d. per share is recommended by the Board for the first half of the current year, carrying forward £3,704.

Change of Address.—The offices of the Epstein Electric Accumulator Company, Limited, have been removed from 34, Cannon street to 19 and 21, Queen Victoria street, E.C.

Indo-European Telegraph Company.—The Board have declared an interim dividend at the rate of 5 per cent. per annum for the half year ended June 30 last, payable on the 1st proximo.

Wigan.—At a meeting of the Wigan Gas Committee last week, it was decided that application be made in the proposed Bill for powers to borrow the sum of £30,000 for electric lighting purposes.

Electrical Omnibus.—The *Daily Telegraph* of Thursday has a long article on electrical omnibuses, and announces that Mr. Radcliffe Ward's 'buses may be expected to be running in London within a fortnight.

Penarth.—The residence of Mr. Thomas Morel, Penarth, is being fitted throughout with electric light by Messrs. J. B. Saunders and Co., of Cardiff. An Otto gas engine, driving dynamo with accumulators, will be used.

York.—We understand that Mr. Crompton, desiring to resign his position as consulting engineer to the York Corporation in reference to the electric lighting scheme with a view to his firm being at liberty to tender, his resignation has been accepted.

Wrexham.—The local electric company at Wrexham is beginning to bestir itself, but there is considerable feeling in the district that the Corporation should take over the concession itself. The St. Pancras success is responsible for a good deal of this feeling.

Personal.—Mr. David Cook, manager, City of London Electric Lighting Company, Limited, who has for some months past fulfilled the duties of engineer as well as those of manager, has been formally appointed engineer and manager to the Company.

Anti-Sulphuric Enamel.—Messrs. Griffiths Bros. and Co. have a new specialty for the electrical trade, in the shape of a flexible shellac insulating varnish which does not crack or become brittle. This firm have a number of special preparations of use to electrical manufacturers.

Torquay.—Mr. Milne, one of the municipal candidates for Torquay, in addressing a meeting last Saturday, said the town was greatly in need of the electric light as the streets were very badly lighted, and he thought the water from the reservoirs could be utilised as motive power.

City and South London Railway Company.—The receipts for the week ending October 23 were £865 against £756 for the corresponding period of last year, or an increase of £109. The total receipts for 1892 show an increase of £1,212 over those for the corresponding period of 1891.

New Swindon.—The New Swindon Local Board have carried a resolution to make an offer to the local gas company. They had considered the cost of electric lighting, but it was found that it would cost £10,000 outlay to light a radius of two miles, and this was considered too expensive.

Chiswick.—At the Chiswick Local Board meeting last week the clerk, in his report, read a lengthy communication from the Board of Trade with reference to the contract with Messrs. Bourne and Grant for electric lighting in Chiswick. The consideration thereof was referred to the Electric Lighting Committee.

Bilston.—At the monthly meeting of the Bilston Town Commissioners, it was resolved that two more lights be placed in the Market Hall, and Mr. Hill remarked that as there had been another slight breakdown in the supply of electric light to the market, it would be necessary to obtain either duplicate machinery or accumulators.

Factory.—We had several enquiries some time back for site and buildings suitable for electric manufacturing shops. In our advertisement columns this week such an opportunity is disclosed, of a mill at Stamford hill, with ample steam power, 3,000ft. area of floor space, water and gas ready, and benches can be arranged suitable for manufacturing or experimental work.

Cambridge.—At the electric lighting works now in course of construction, an accident occurred on Tuesday morning by the falling of a quantity of brickwork in the furnace-room. Several workmen were more or less injured, and one, W. Burgess, of Chesterton, who was extricated with difficulty, had to be taken to the hospital, having sustained a severe scalp wound.

Torpedo Patents.—The whole of the patents and patent rights of Gibben's torpedo inventions are for sale, with building, show-room, mines, electrical table and apparatus, batteries, office furniture, and goodwill of the Submarine Mining and Torpedo Company, Limited, in liquidation. Application for cards to view to be addressed to Mr. F. Thorn, 37, Walbrook; Showrooms, Westcombe Station, S.E. Railway.

Steam Turbine Alternator.—We understand that Prof. Ewing has concluded his report upon this combination, and has obtained extremely interesting results as to economy. It is said that the result shows an economy equal to the best compound engine, or 15lb. of steam per indicated horse power, with 100lb. boiler pressure. The report is accompanied by curves, the whole of which we hope to give in our next issue.

Waterford.—The *Waterford News* exclaims against the policy of the Town Council, who, a few weeks ago, objected that they would not be able to raise the £3,000 necessary for electric light, are content to lose the £400 paid for the provisional order, the £400 a year saved over the cost of gas, and now ask for a large sum for a costly reconstruction of legal status as regards bridges and harbours of doubtful utility to the town.

Arlecdon.—At the Arlecdon and Frizinghall Local Board meeting, the question of the electric lighting was discussed, Mr. Boyd stating that the pressure gauge, which was ordered to test the pressure of their water supply, had not arrived yet, but he thought it would be there shortly. Circulars had been received from two separate firms, makers of the electric lighting apparatus, stating that they would be willing to undertake the work.

Extension of Premises.—Mr. R. W. Paul, of 44, Hatton-garden, E.C., has, owing to the increasing demand for the various electrical and physical instruments made by him, taken additional premises in Leather lane, to enable the firm to better cope with the larger trade orders. The new workshops have been fitted with steam power and modern machine tools, but the experimental workshops, test rooms, and office remain at Hatton-garden as before.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino Brazilian Company, were £3,486. The Board of this Company has decided that after placing £14,000 to the reserve fund and £6,610 10s. to the debenture redemption fund, the Directors would recommend, at the forthcoming meeting, a dividend of 3s. per share, free of income tax, being at the rate of 2 per cent. per annum for the six months ended June 30 last, carrying forward £1,662.

Burnley.—The Electric Lighting Committee of the Burnley Corporation are at present considering tenders for electrical plant for the lighting of the borough by the new illuminant. The central station for the generation of the electricity is to be situated in Aqueduct street, and the contracts for the buildings have already been let and the work commenced. Consumers will be required to provide their own lamps and fittings, and the wires will have to be fitted in accordance with special regulations issued by the Corporation.

Large Cargo Steamer.—The steamer "Samos," the largest vessel yet built on the Wear, and indeed the largest dead weight cargo vessel in the world, was successfully launched from the yard of W. Doxford and Sons, Limited, Pallion, before a large and interested concourse of people on Saturday. The vessel which is built of steel, and classed 100 A1 Lloyd's, is 465ft. long, 52ft. breadth, and 36ft. depth, has a gross register of 6,400 tons, dead-weight capacity of 9,250 tons on 25ft. draught, and gross displacement of 13,600 tons. The vessel is to be lighted throughout with electric light.

Edison Electric Company.—Mr. Philip S. Dyer, European agent of the Edison General Electric Company, writing from 34, Victoria street, Westminster, informs us that on account of the recent consolidation between the Thomson-Houston Electric Company and the Edison General Electric Company of America (now called the General Electric Company of New York), the European business of the Edison General Electric Company will be transferred on and after November 1st, to 7, Rue du Louvre, Paris, and the future business will be carried on from that office by Mr. E. Thurnauer, who, after that date, will represent in Europe the Edison General Electric Company, which company is part of the General Electric Company of New York.

Montevideo Telephone Company, Limited.—The report of this Company for the year ending July 31 shows a profit, including £470 brought forward, of £6,879, after providing for all working expenses in Montevideo and London, and after writing off £129 for proportion of preliminary expenses and £50 for depreciation of furniture at head office and in Montevideo. A considerable reduction has been effected in the general working expenses. In Montevideo the net decrease as compared with last year is £2,000, and in London £406. This latter item is almost entirely due to the reduction and final extinction of the managing director's salary, Mr. E. F. Powers having resigned this position. The Directors recommend that £5,000 be placed to reserve account, and the balance of £1,879 carried forward.

Chamber of Commerce.—At the meeting of the London Chamber of Commerce last Friday, after a good discussion, the

following resolution was ultimately passed. We have elsewhere commented upon the action of the section of the Chamber of Commerce, therefore we need do no more than give the resolution and the names of the committee appointed as follows: "That a sub-committee of the section be appointed to consider the whole question of the regulations of the Board of Trade, to confer with the Institute of Electrical Engineers, to suggest a course of action, to collect information, to submit witnesses, and to report from time to time to the section." The following gentlemen were afterwards appointed as the sub-committee: General Webber, and Messrs. Raworth, Ferranti, William Grey, Pott, Wharton, Garcke, Bayley, Erskine, T. Parker, Gordon, Swinburne, and Crompton.

Bolton. As a result of the visit of a deputation the Bolton Electric Lighting Committee have decided to recommend the system in use at Oxford as the most suitable one for Bolton. The Electric Lighting Committee will meet during the course of a few days to receive the final report of the sub-committee, and also to consider a number of tenders which have been sent in. The system proposed to be adopted will also be capable of driving the trams in the event of the Corporation deciding to take them over at the expiration of the lease next year. The accumulator system will be used. It is not intended to entirely substitute gas by electric light, but the committee consider themselves justified in proceeding with the matter, seeing that applications have already been received from shopkeepers and owners of large works in the town for over 2,000 16 c.p. lamps. The committee's report will be published.

Taunton. The following calculation of loss at the Taunton works is given by the *Somerset Express* ("open to amendment"). Taking Mr. Potter's statement that the net loss on the working for 1891 was £376, we have also Mr. Kapp's estimate of repairs and renewals as follows: Buildings, £40; steam and dynamo plant, £230; batteries, £100; street mains, £100; arc lamps, £20; total, £490. These are the figures of Mr. Kapp, the expert called in by the Town Council. This makes £836 on the wrong side. Nothing is yet put down for a redemption fund, though, from a business point of view, it ought not to be overlooked. Add to the amount already arrived at, £700 interest and instalment on loan of £14,000 and £300 to £400 paid for street lighting over and above the price charged for gas, and we get, says the writer, £1,800 or more for the electric light over and above the cost of lighting the town with gas.

Bromley. The Electric Lighting Committee of the Bromley Local Board have reported that at their meeting on Oct. 11 they considered the steps to be taken for giving effect to their electric lighting order, and they recommended that the clerk and the surveyor be instructed to draw up and issue a circular to householders to ascertain the number of householders willing to take electric lighting on circuit, as suggested by Prof. Kennedy, and the approximate number of lamps required. The clerk reported that the Highways Committee would recommend the Board to proceed with the negotiations for the purchase of a piece of land in the Station road, a portion of which would be available for the erection of an electric lighting station. A letter was read from the Local Government Board transmitting a copy of a letter from Mr. H. J. Lansbury, who stated that the period specified in the first schedule of the provisional order had now expired, and enquired whether an extension of time had been granted. As the order was not granted until July, 1891, the period specified did not expire until July, 1893, and the committee recommended that the clerk be instructed to reply in accordance with the facts.

Windsor. At the meeting of the Windsor Town Council last week a long discussion was held on the position of the electric light company. It was explained that the contractors, Messrs. J. E. H. Gordon and Co., were carrying on a certain portion of the work as a pioneer installation. Mr. Dyson proposed that as the Board of Trade had no power to grant an extension of time the Board be requested to revoke the provisional order. Mr. Drewe moved an amendment that the Council regret that the electric light company have not satisfied the Board of Trade that they are in a position to fully and efficiently discharge the duties and objects of the provisional order, but in order not to prejudice the action of the Council in future the town clerk give notice to the Windsor and Eton Electric Light Company, under section 14 of the order, that the Corporation disapprove of the company opening and breaking up any of the streets or highways or continuing any other works until they have satisfied the Board of Trade as required by section 7 of the provisional order. This amendment was carried, no one voting against it, the Mayor and other members having left the chamber. Mr. Soundy then moved that a committee of the non-interested members of the Council be appointed to confer with the electric lighting company and report to the Council. This was also carried.

South Staffordshire Trams. In a few days nine miles of the South Staffordshire electric trams will be at work on the overhead conductor system. The preparatory work is almost complete, and experimental runs have been made along the entire route. A large power station has been erected between Darlaston and Wednesbury, containing three large dynamos driven by three compound condensing engines of 150 i.h.p. The districts which will be worked by the electric cars are those between Wednesbury and Bloxwich, Darlaston and Walsall. The feed cable, which is of solid drawn copper wire, is about ⅜in. in thickness, No. 0 B.W.G. It is suspended from the projected bracket of a series of iron poles placed on the sidewalk of the roads against the kerbstones, and carried at a uniform height of 21ft. from the ground. Underneath it runs a trolley wheel which is projected at the end of an arm attached to the roof of the cars. In this way connection is established between the lines and the motors, which are placed out of sight beneath the floor of the car. The pressure of the current conveyed along the feed wire does not exceed 300 volts, which is the utmost the Board of Trade will allow in England. The cars are constructed upon the bogie principle and have only two wheels at either end. Both the motors are of 15 b.h.p. The return circuit is made through the rails and the earth to the generating station. The switches and brake levers on the cars are fixed under the steps at either end, and the driver stands in front in whichever direction the car may be traveling. Electricity is also employed as illuminant, and both inside and out the seats are constructed upon what is known as the garden principle, with reversible back rests. The construction of the line has been carried out under the superintendence of Mr. Alfred Dickenson, C.E.

Eastern Extension Company. The report of the Directors of the Eastern Extension Australasia and China Telegraph Company, Limited, for the half year ended June 30, 1892, states that the gross receipts, including Government subsidies, have amounted during that period to £246,988, against £254,878. The working expenses, including £26,430 for cost of repairs to cables and expenses of ships, absorb £79,282, against £71,177, leaving a balance of £167,706. From this is deducted £3,041 for income tax, £31,895 for interest on debentures, debenture stock, and contribution to sinking fund, leaving £132,771 as the net profit for the half year. Two quarterly interim dividends of 1¼ per cent. each, amounting to £62,500, have been paid for the half year, leaving £70,271 to be carried forward. An arrangement has been entered into with the Government of New Zealand for reducing the tariffs over the New Zealand cables from 3s. 6d. to 2s. per 10 words for inter-colonial telegrams and from 1s. to 3d. per word for international telegrams, the Government guaranteeing the Company against three-fourths risk of any loss that may arise from the reductions, and the Company bearing the remaining one-fourth. It has also been arranged for the Government of New Zealand to join in the Australian guarantee and receive the benefit of the reduced rates with Australia, but owing to the losses during the first year of the experimental tariff having been greater than was anticipated by the colonies, the guaranteeing Governments have requested the Company to increase the charges for ordinary telegrams by 9d. per word, making the rates between Europe and Australia as follows: 4s. 9d. per word for South and West Australia, 4s. 10d. per word for Victoria, 4s. 11d. per word for New South Wales, 5s. 2d. per word for New Zealand, 5s. 5d. per word for Tasmania, and 5s. 5d. per word for Queensland. The changes of tariff will probably take effect from December 1 next.

Bradford. The Bradford Town Council have agreed to sanction the application for a provisional order to expend £30,000 upon the extension of their electric lighting supply. At the Town Council meeting on Wednesday, Alderman F. Priestman, chairman of the Gas and Electricity Supply Committee, moved the adoption of the minutes of that committee. He said the minutes included a provision granting to the committee borrowing powers to the amount of £30,000 for the extension of works. The committee required something like £9,000 to complete part of the electricity works already sanctioned by the Council, the remaining money would probably be required for an extension in years to come. There was nothing of the sort coming up just at present. In fact, the committee had no intention of recommending extensions of merely prospective utility. The public were continually demanding increased supplies of electric light, and of course the committee would need capital if they were to cope with the growing demand. He hoped to see the day when the committee would have to come before the Council to ask for five times as much money as they now needed. He certainly hoped that the supply of electricity was going to be a distinctly progressive work. Some enquiry ensued as to the cost of lighting the town clock. This was stated to amount to £840 a year, at which Alderman Priestman expressed astonishment. The matter was one which really belonged to the Finance and General Purposes Committee, and no doubt the chairman of that committee had already considered as to what was the best course to take. There were many ways of reducing the cost of the illumination. Personally he was often puzzled to tell the real difference between the 8, 16 and 32 candle lamps. Perhaps the 32 candle lamps in use might, without inconvenience, be changed for 8 candle ones, or, on the other hand, the total number of lamps might be reduced. The minutes were approved.

Taunton. The Directors of the Taunton Electric Lighting Works, not being altogether satisfied with Mr. Kapp's report, Messrs. Laing, Wharton, and Down requested Dr. J. A. Fleming, of the University College, to report on their behalf. Generally speaking, it is more favourable than Mr. Kapp's, but the conclusions arrived at are much the same: the works and plant are equal to three times as much work as is now being done. If the output were increased to that extent the works might pay. The following is Dr. Fleming's summary: "1. That the system of electric lighting now in operation at Taunton is one which is, in my opinion, best adapted to the present requirements of the town. 2. That the plant is in very fair condition, and is of a thoroughly good type, and the general arrangements and site of the station have been made with all reasonable forethought for the future. 3. When the whole of the power available is being taken up, and some small additions made to it, there is no reason to doubt that it will be capable of producing the full output of which it is capable at a cost which will leave a margin sufficient to provide the necessary annual amount for the redemption fund for the first cost and for extensions necessary, if

it is taken over by the Corporation as it stands, at the figure which has been arrived at as its fair purchase value. 4. Taking it as it stands, and assuming that the necessary custom can be obtained (which is almost certain) to fully load up the existing plant, and provided that the minor improvements suggested, especially the use of a small alternator and the introduction of meters, are effected, I see no reason to think that the working of the plant daily from dusk to dawn will result in financial loss. On the other hand, the difference between the full gross possible revenue and total generating expenses should be sufficient to provide an annual contribution of £680 towards the redemption fund, and as the lighting extends should leave a margin of profit. 5. Having regard to the state of the plant, and its original total first cost—a statement of which I have been shown—and the fact that the proposed purchase price includes the freehold of the land, I do not consider that the proposed purchase price, which I understand is fixed at £9,300, is an unreasonable figure for the acquirement of a plant suitable for the supply of 1,500 16 c.p. incandescent lamps and 90 arcs. 6. If the arc and incandescent lighting is extended to the whole of the streets of the town, and if custom outside by private consumers can be obtained equal to a yearly demand of 100,000 units, I think that electric lighting might become a source of profit to the ratepayers."

Oxford.—Since the opening of the works of the Oxford Electric Lighting Company on June 18 last the progress of the business has been extremely favourable. Numerous applications for current have been received, and a large number of lamps are already connected with the mains. The public lighting of the streets in the centre of the city has been undertaken, and a number of the colleges, the theatres, hotels, and many places of business have been lighted. No electric supply company has started under more favourable auspices. The very perfect system of distribution has worked without a hitch, proving not only the admirable character of the machinery, but the great care with which the installation has been carried out. The chairman remarked on the occasion of the opening of the works that "the business of supplying electricity has passed its experimental stage, and has reached a development that there is little or no practical difficulty in furnishing a city with a supply of electrical energy which can be used for purposes of lighting, power, or traction, or even of cooking, of which you have seen illustrations presented to you this evening;" and, in fact, the economy of the system of supply promises to give a most favourable return to the shareholders of the company. The excellency of the machinery and the intelligence with which it has been worked has resulted, we understand, in an extraordinarily small consumption of coal for the output of electricity obtained. The Company's showroom has been supplied with a choice selection of fittings, especially adapted to the requirements of this city. The firms who have united in furnishing the Company's showroom are the following: Messrs. Benham and Froud, Limited; Laing, Wharton, and Down; Messrs. F. Osler and Co.; Strode and Co., Limited; and Frank Suter and Co.; besides cooking apparatus, motors, etc., by the General Electric Company, Limited. The applications for current received by the Company include the Corporation, for the lighting of High-street, Cornmarket-street, Queen-street, and St. Aldate's-street, with 16 Brockie-Pell arc lamps of 1,200 c.p. each, the price paid by the city being £27 per annum for each lamp burning all night, and £14 for half-night lamps; the contract is for three years. The theatre and principal hotels are lighted, and besides many of the tradesmen the following colleges take the light: Brasenose College, Hertford College, University College, Trinity College, Balliol College, Magdalen College, St. Mary's Hall. Since the commencement of the works the board of directors has been increased by the addition of Alderman Robert Buckell and L. A. Selby Bigge, Esq.; and Sir Henry C. Mance, C.I.E., has become chairman in the place of J. Irving Courtenay, Esq., who remains a member of the Board. The lamp-posts fixed at the top of St. Ebbe's and near the Martyrs' Memorial and other places were manufactured of wrought iron at Munich for the Company with the special object of suiting the architectural character of the city. The remainder have been manufactured by the Electric Construction Corporation, of Wolverhampton. In comparison with the lamp-posts erected in the City of London and other towns the design reflects credit upon the taste of the Company.

Dundee Station.—The *Dundee News* gives the following information relating to the work at the central station: "As it is expected that the central portion of Dundee will be illuminated by electricity before the New Year, some information relative to the construction of the works, as well as the position the city will occupy in reference to the illuminant as contrasted with other centres where it has been adopted, may prove of some general interest. The contracts for the works were accepted about the beginning of June, and work was begun at the central station in July. Satisfactory progress has all along been made—the main walls of the engine and boiler houses being now completed, and a commencement has been made with the roofs. The works consist of a one-storey range of offices facing Dudhope-crescent road, with a basement below for the storage batteries. Behind the offices are situated the engine and boiler houses. The engine house is 65ft. long and 25ft. 6in. wide, and it is handsomely decorated with enamelled brick, with a dado of coloured brick. There is also a freestone corbel for carrying the rails supporting the travelling crane. The engines, which have been contracted for, are six of the well-known Willans and Robinson type, and four of these are to indicate 135 h.p. each, and the remaining two will each indicate 60 h.p. The dynamos, which were provided by Messrs. Siemens and Co., London, are attached direct to the engine shafts, being fixed on the same bed plates, so that there is no belting or shafting of any kind. The boilers will be of the Lancashire type, and are being constructed by Messrs. Whyte and Cooper, Dundee. The same firm are also providing one of their air condensers, which will be placed on the roof of the boiler house. The arrangement is rather a feature of the Dundee electric works, and it should be mentioned that it is the only electric lighting station which has been fitted up with this class of condenser. Already the condensers have attracted the notice of electricians elsewhere, and enquiries have reached the station from time to time as to their mode of working. The switchboard, which will be placed in the engine-room, will be 24ft. long by 6ft. high. It is to be constructed on slabs of slate 1½in. thick, and on it will be placed the various instruments required for measuring and controlling the large currents which are to be dealt with. From the station the current will be carried by strips of bare copper supported in porcelain insulators in a concrete culvert to the distribution mains. Many of our readers have, no doubt, watched with interest the construction of these culverts during the six weeks that this work has been going on. These will extend from the lighting station to the Nethergate via Barrack-street and Tally-street, and to Murraygate by Meadowside-road, Panmure-street, and Commercial-street. Junctions will be formed between them and the distribution mains at the corner of Tally-street and Nethergate, at the top of Reform-street, and at the corner of Commercial-street and Murraygate. The distribution mains will consist, on the other hand, of cables insulated with vulcanised indiarubber and drawn into iron pipes. Considerable speculation has existed as to the manner in which the wires would be inserted into the pipes, having regard to the fact that the latter are laid before the wires. The method employed in getting the wires into their places can now be seen in operation. It consists of pushing a series of short bamboo rods connected by screws into the pipes in a manner very similar to that by which a chimney-sweep passes his brush up a chimney. Once the rods are through a rope is attached to the end, the rods are withdrawn, bringing the rope through the pipe, and these in turn serve to pull the cable through. An incident connected with the construction of the concrete culvert in Tally-street may be recorded. In the course of their operations the workmen dug up a considerable number of old bones, showing that the old parish churchyard must have extended over a considerable space beyond the present church grounds. Again, in Commercial-street the contractors in their excavations were greatly retarded, heavy blocks of stone—the remnants of old buildings—having to be cut through. Otherwise the work has proceeded without any special difficulty. The area within which the Gas Commission have at present parliamentary powers to supply electric energy is a small but compact one, comprising the centre of the city, so that the proportion between light supplied and lengths of street mains will probably be a very favourable one as compared with most other cities. Most of the London supply companies are charging from 7d. to 8d. per unit, although their output is a very much larger one than the Dundee works can ever hope to attain too. But against this it has to be remembered that their capital charges for the construction of street mains are immensely higher. It is expected that the cost for the Dundee works will not exceed £21,000, of which £7,500 is for the construction of street mains. In London, on the other hand, the cost of the mains vary from 50 to 75 per cent. of the total expenditure, so that Dundee occupies an advantageous position in this respect. The distribution mains being laid in iron pipes, it is, of course, impossible to make connections to these for the individual houses without breaking the pipes. Provision has, however, been made for this by leaving gaps in the pipes and constructing brick boxes there with covers in the pavement. At each of these points connections can thus be taken off to the adjacent houses. Where these boxes have not been provided the pipes will have to be cut to supply customers. As the work is being carried out by the Gas Commissioners, who have already a considerable clerical staff, it will not be necessary to provide a separate staff for the electric lighting works, and thus a further saving will be effected. This, of course, means a smaller capital expenditure, and it may therefore be hoped that the Commissioners may be able to make the works pay even at the low charge of 5d. per unit as fixed upon. The engine power at present provided for is sufficient for supplying 5,000 incandescent lamps, each of 16 c.p., and it must be gratifying to the Commissioners that already about 1,500 lights have either been contracted for or are in contemplation. Many of the large shops in the High-street and Nethergate have taken the light. The Eastern Club have negotiated for it, and it will no doubt be adopted in other large buildings. It is, indeed, anticipated that once the works are in full swing many who are at present holding back until they see the light introduced will become customers. The present system is the low-tension one, and therefore cannot be extended further than from 1,000 to 1,500 yards from the works. This would, however, include the whole of the residential district near the Barrack Park and the crescents behind the infirmary. No doubt the Commissioners will apply for the extension of their area in this direction provided they are warranted by a sufficient demand for the illuminant. The Commissioners are not precluded from supplying electricity to a much greater distance, as it will be remembered that in their original report the engineers proposed that the Perth-road district should be supplied by a high-tension current, which would be converted into a low-tension one at a sub-station before being delivered to consumers. This is a system which is now working very successfully in Oxford, where the whole of the current is produced at a station two miles out of the town, brought in on the high-tension system, and converted and distributed on the low-tension system. The question of the comparative

cost of electric light and gas light is a very important one to would-be consumers. Unluckily, it is a problem with so many indefinite qualities that it is almost impossible to state positively what should be the proper method of comparison. If both gas burners and electric lamps are assumed to be of the actual candle-power which they profess to be, and be placed in the same positions in a room or shop, and lighted for the same number of hours, the electric light at 5d. a unit would cost 1½ times as much as the gas jet supplied with Dundee gas at 3s. 9d. per 1,000 cubic feet. (In London the proportion on the same assumption is 2½d.) The above assumption, however, does not correspond to facts. The case is altogether different if we may believe Mr. W. H. Preece, F.R.S., electrician to the General Post Office, who, after a series of experiments on gas burners, ascertained that the ordinary house burner, from various causes, such as dirt, unequal pressure, etc., only gives 66 per cent. of its nominal candle-power. This is one element of uncertainty in the calculation. Electric light offers especial facilities for subdivision, and there is no objection to placing a lamp close to the surface it is required to illuminate, and thus a careful arrangement of the lights will often allow of a better illuminating effect being produced with a smaller total of candle-power. It therefore depends to a very great extent on the skill and experience of the engineer who fixes the position of the lamps whether the quarterly account for electric light will be higher or lower than the gas account used to be. Again, it is almost impossible to estimate beforehand what saving will be effected in the cost of cleaning and painting premises by the introduction of electric light. One example bearing on this point may be cited. Prior to the introduction of electric light into the Dundee Free Library the handsome wooden ceiling had to be cleaned and varnished every year, and yet it had still quite a dirty appearance six months after it was so dealt with. Quite a different state of matters has prevailed since the introduction of the new illuminant, the ceiling not having been cleaned for three years, and yet it looks quite fresh. While the lighting of Dundee has not been at any time a subject of complaint, it has frequently been remarked that many of our principal thoroughfares are not so well lighted as they might be. In the circumstances the step taken by the Police Commission yesterday to have the portion of the High-street in the vicinity of the Town House illuminated with electricity will be hailed with satisfaction. The Commission have entered into the arrangement as an experiment, but should it be successful the light will in all probability be adopted in several other of the principal streets. Before this time next year it may be hoped that all the main streets will be lit with arc lamps. The only other place in Scotland at present going in for electric energy is Glasgow, and it is to be hoped that Dundee will be the first to be lit up. One thing is certain, that much will depend on the success of the Dundee scheme in inducing other cities to have the illuminant introduced."

PROVISIONAL PATENTS, 1892.

OCTOBER 17.

18538. **A new construction of underground conduit for electric conductors.** Thomas Wallace, 65, Chancery-lane, London. (Complete specification.)

18542. **Improvements in certain brackets or supports for electric arc lamps, applicable also for supporting lamps of other kinds.** James Kershaw Grindrod, 18, St. Ann's-street, Manchester.

OCTOBER 18.

18602. **Improvements in electrical appliances for canes and analogous articles.** Stephen Douglas Smith and Oscar James Wells, 52, Chancery lane, London.

18661. **Improvements in electrical communication between lightships and other vessels, and for other purposes.** James Harold Barry, 26, Budge row, Cannon street, London.

OCTOBER 19.

18691. **Improvements in underground conductors for the distribution of electricity.** Sydney William Baynes, 37, Spring gardens, Manningham lane, Bradford.

18695. **Bannister's new and improved electric railway signal and point working system.** Charles Alfred Bannister, 40, Mornington road, Regent's Park, London.

18700. **Improvements in electrical ceiling roses.** Thomas George Poole and Woodhouse and Rawson United Limited, 88, Queen Victoria street, London.

18716. **Improvements in electric wire or cable conductors or conduits.** Alexander Kinnear Foote and Henry Richmond Potter, 70, Wellington street, Glasgow.

18732. **Improvements in the regulating devices of alternate-current arc lamps.** Joseph Sinclair Fairfax, 433, Strand. (Messrs. Schuckert and Co., Germany.) (Complete specification.)

18739. **Improvements in or relating to telescopic slides for electroliers, electric brackets, electric floor-lights, and the like.** George Frederick Sanders, 37, Chancery lane, London.

18763. **Improvements in and relating to electric apparatus for playing mechanical pianos, organs and other keyed musical instruments.** Alphonse Antoine Magnier, 45, Southampton buildings, Chancery lane, London.

OCTOBER 20.

18780. **An improved method of registering the value of an electrical current on one meter where the price per unit varies for different services.** George Harris Driver, 210, Euston-road, London.

18807. **Electrodes for secondary batteries.** Emile Andreoli, 16, Somerleyton road, Brixton, London.

18817. **Improvements relating to galvanic batteries.** John Alexander M'Mullen, 124, Chancery lane, London.

18844. **Improvements in dry cells or galvanic batteries.** Hugo Koller, 46, Lincoln's inn fields, London.

OCTOBER 21.

18847. **Improvements in alternating-current motors.** Henry Francis Joel, 44, Lavender grove, Dalston, London.

18866. **Improvements in and connected with the protection of electrical conductors and fittings.** Andrew [illegible] and Carrington Riddell Gordon Smythe, 5, Downes [illegible] rant, Kelvinside, Glasgow.

18868. **Improvements in unions for electric chandeliers.** Louis Ballet, 4, Corporation street, Manchester.

18878. **Improvements in the connections of the [illegible] of earthenware articles employed in connection with electrical switches, cut-outs, ceiling roses and the like.** Thomas Taylor and William Tunnicliffe, 8, [illegible] street, Birmingham.

OCTOBER 22.

18926. **Improvements in switch lampholders for electric lighting purposes.** Frank Geere Howard, 10, Berners street, London.

18965. **Process for the electrolytic decomposition of compounds of metals and sulphur.** Siemens Bros. and Co., Limited, 28, Southampton buildings, Chancery lane, London. (Messrs. Siemens and Halske, Germany.)

18982. **Improvements in telephonic apparatus.** Edward Peake Davis, 55, Chancery lane, London.

18994. **Improvements in electromagnets.** Illius Augustus Timmis, 2, Great George street, Westminster, London.

SPECIFICATIONS PUBLISHED.

1891.

16572. **Dynamo electric machines, etc.** Sayers.
16034. **Secondary batteries.** Lake. (Kennedy and another.)
16938. **Secondary batteries.** Lake. (Kennedy and another.)
18451. **Telephonic switching apparatus.** Bennett.
18976. **Arc electric lamps.** Parker and Rees.
19630. **Electric cables.** Hardingham. (Felten and Guilleaume.)
19775. **Electrolytic decomposing apparatus.** Breuer.
19899. **Telephone closets.** Weighill.
20144. **Electrical and telephonic signals.** Eggar.
20231. **Telephonic transmission.** Mayer.
20279. **Electric cables.** Hardingham. (Felten and Guilleaume.)
20718. **Electric boot and shoe grinders.** Pinckney.
20825. **Electrical cables.** Edmunds and Preece.
21720. **Electric switches.** Howell and Pownall.
22542. **Conducting electricity to lamps.** Phillips and Raw.

1892.

4523. **Incandescent electric lamps, etc.** Rios Electric Speciality Company and others.
11353. **Electrical alarm clocks.** Mullarky.
11941. **Electricity meters.** Miller.
14089. **Galvanic batteries.** Lowenberg and another.
14814. **Storage batteries.** Usher.
14816. **Electric battery plates.** Usher.
15167. **Electrically-illuminated signs, etc.** Mills. (Page and another.)
15690. **Electric railways.** B. and A. Kochs.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	Price Wednesday
Brush Co.	—	[illegible]
— Pref.	—	[illegible]
City of London	—	[illegible]
Electric Construction	[illegible]	3½
Gatti's	—	[illegible]
House-to-House	5	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]
London Electric Supply	[illegible]	[illegible]
Metropolitan Electric Supply	—	[illegible]
National Telephone	[illegible]	[illegible]
St. James'	—	[illegible]
Swan United	[illegible]	[illegible]
Westminster Electric	—	8

NOTES.

Tesla.—Mr. Nikola Tesla is to deliver a lecture at the meeting of the National Electric Light Association at St. Louis.

House Lighting.—The title of Mr. Angelo Fahie's book is definitely announced as "House Lighting by Electricity."

Junior Engineering Society.—The presidential address by Dr. Hopkinson before this society takes place to-night (Friday) at eight, at the Westminster Palace Hotel.

Altona.—The State authorities of the city of Altona have granted a license to Herr Beringer, engineer, of Charlottenburg, to build an electric railway from Altona to Blankenese.

Plante Premium.—M. Gaston Planté left a legacy of 1,500 francs to be given as a prize to the person who makes an important advance in electrical science, and the French Académie des Sciences have accepted the responsibility.

Optical Telegraphs.—Experiments in optical telegraphy made in France on Mont-Valérien, with the aid of electrical apparatus, have demonstrated that it was possible to communicate with Rouen, a distance of 120 kilometres.

Institution.—The Institution of Electrical Engineers will open its session for the winter on November 10th at 25, Great George-street, Westminster, at 8 p.m., when a paper on "The Problems of Commercial Electrolysis," by Mr. James Swinburne, member, will be read.

Aluminium Electroplating.—The *Scientific American* for October 22 describes and illustrates some huge electroplating tanks erected at the Tacony Iron and Metal Company's works for electroplating with aluminium the great pillars and iron parts of the new City Hall of Philadelphia.

Smoking Concert.—The Electro-Harmonic smoking concert last Friday was a great success, Mr. Ganthony's amusing imitation of a phonograph being much appreciated. Mr. Gatehouse discoursed sweet music on the violin, and the part-songs and solos were received with rapturous applause.

Potential of the Atmosphere.—The readings of the instruments established by M. Mascart on the Eiffel tower serve to show that the increase in potential of the atmosphere with the height above the ground is a physical fact, and one likely to be of great utility in dealing with meteorological observations.

Mount Washington.—The carbons of the celebrated Mount Washington arc are those of Hardmuth, of Vienna; the positive one measuring 1½in., and the negative 1in. in diameter. The projector has a Mangin lens of nearly 15in. focus, and was made in Paris after a secret process by which the quicksilver of the reflector is not injured with the heat of the arc.

University Extension at Plymouth.—In continuation of the series of 12 lectures on "Electricity and Magnetism," Mr. H. L. Callendar, M.A., delivered an interesting lecture at Plymouth Technical Schools on Monday, on the chemical effects of the current. Striking experiments on electrolysis and electroplating were exhibited on the screen. There was a very gratifying attendance.

Village Lighting.—A small installation in the village of Liebenau, in Hesse, Germany, has just been completed by Messrs. O. von Miller and Co., of Cassel, for the mills of Baron von Pappenheim. The plant consists of a small dynamo, driven by the mill wheel, and 60 incandescent lamps. The latter are used for lighting the mills and also the principal street of the village, which, it is claimed, is the smallest in Germany that can boast of electric lighting.

A Methusaleh Lamp.—Mr. Ernest Kitson, of the Edison Company station at Bellefonte, Pennsylvania, has an Edison 107-volt 10-c.p. lamp, which he says was put in circuit April 1st, 1884, and has been in use constantly at an average of 13½ hours a day until May 30th, 1892, a total period of eight years and two months. This would give the lamp a total life of 40,000 hours—apparently the record up to the present. In addition, it is stated that during the last three years the voltage on the circuit has been 110 volts or over.

German Electric Tramways.—In the city of Gera an electric street tramway, designed and erected by the Allgemeine Company, of Berlin, on the overhead conductor or trolley-wire system, which was completed last spring, has seven miles of single track. Phœnix rails are employed for the surface permanent way, whilst for the overhead construction both metal girder and wooden poles have been erected to carry the conductor wires. The generating station serves not only to supply current for operating the tramway, but also for electric light and power purposes throughout the town.

Telephonic Communication at Flamborough Head.—The Trinity House, who are in charge of the lighthouses on the coast, have connected by telephone the lighthouse and fog-signal station. For some years two resident signalmen were located at the signal station, and a continual watch was kept for fogs by one or other of the men. The telephone has now been fixed so that in clear weather the signalman can retire, whilst the light keeper who is on watch has to observe when a fog arises, and then to communicate the fact to the fog-signal station without having to leave his post.

Electrical Standards.—A meeting of the Electrical Standards Committee was held at the Board of Trade on October 27. The committee discussed the report made to the British Association by the Electrical Standards Committee of the association in August last, and considered the supplementary report they propose to make to the Board of Trade. The following members were present: Sir Courtenay Boyle, K.C.B.; Major Cardew, R.E.; Mr. W. H. Preece, F.R.S.; Lord Kelvin, F.R.S; Lord Rayleigh, F.R.S.; Prof. G. Carey-Foster, F.R.S.; Mr. R. T. Glazebrook, F.R.S.; Dr. John Hopkinson, F.R.S.; and Prof. W. E. Ayrton, F.R.S.

Franklin Institute.—Papers were read before the Electrical Section of the Franklin Institute, Philadelphia, on the 25th ult., on "A New Ballistic Galvanometer, (*a*) With High Insulation and Graded Coils, and Constructed Closely to Theory; (*b*) With a New Method of Varying the Sensibility within the Widest Limits without the Use of a Control Magnet," by Elmer G. Willyoung. Also on "Some New Apparatus for the Most Exact Comparison and Adjustment of Resistance Standards and the Determination of Temperature Coefficients," by the same author; and "On the Measurement of Energy in the Three-Phase System," by Mr. Paul A. Winand.

Globular Lightning.—A curious instance of globular lightning is referred to in the *Meteorologische Zeitschrift* for September, 1892. On August 7, during a thunderstorm at Altenmarkt, near Furstenfeld, while the priest was administering the sacrament, the church was struck by lightning, followed by a loud explosion. A panic immediately ensued, and the congregation rushed out, notwithstanding the assurances of the priest that there was no danger. There was nothing to show how the lightning entered the church, but it is supposed it was by the conductor leading from the steeple. It is said to have been a

large globe, tapering towards the upper part, and after the explosion it left a strong sulphurous smell. The explosion was very loud and shook the building.

Accumulator Traction in New York.—The invasion of the accumulator into New York continues, and promises to grow serious. Nothing astonishes the American electrical engineer so much as the immense importance of secondary batteries in England except it be the backwardness of electric traction. We lately mentioned that a large order for accumulators had been received in England for a central station in New York. We now notice that accumulators for traction purposes are beginning to be used there also. The Waddell-Entz Company is to place on the Second-avenue line 10 cars of the regulation kind, 16ft. bodies, finished in highest style, equipped with Waddell Entz slow-speed single-reduction motors, driven by storage batteries of the same company. A power station, containing direct-driven dynamos and complete generating plant, will be erected at once.

Tea-Drying by Electricity.—The practice of electrical engineering is very different from other branches of engineering—for instance hydraulics and mechanics, inasmuch as, while the latter are fairly well defined in their scope, no one really knows what branch of business electricity will not next invade. And in this lies the great charm, and the great chance for young electrical engineers. At any time an entirely new field may open out lying quite outside ordinary practice. Of this we have a very good example in the business of tea-drying in Ceylon, now proposed, we see, to be carried out by means of electricity with a simple, clean, and economical process. Some gentlemen resident in Ceylon have brought the idea before certain influential electrical and mechanical engineers, we are told, in England, and the idea being favourably reported upon, may result in transforming the process.

Ring Lubricator.—A modified system of ring lubricators for dynamos has been brought out by M. Fabius Henrion, electrical engineer, of Nancy. The usual ring lubricators, now well known, consist of a ring of metal loosely hanging on the axle and dipping into a well of oil. This arrangement secures continuous lubrication, but at expense of oil, which is thrown off by centrifugal force, and also makes the box liable to become very greasy. M. Henrion's improvement, shown by drawings in the *Revue Industrielle* of October 22, has a well below the bearing partly filled with water, and on this floats some oil. The ring, which is pierced with round holes, rotates in a small chamber, passing through the bush of the axle. Some spider-leg wires lead off the oil drawn up by the ring. The ring itself is enclosed by an envelope, and the lubricator has been found to give great satisfaction.

Technical Instruction.—The Edinburgh School Board have taken a noteworthy initiative in introducing technical instruction in the shape of practical chemistry and manual training into the Sciennes Board School. Of the £700 voted by the Council, £350 has been applied in this school, under Mr. S. M. Murray, in fitting four rooms at the top of the building for technical instruction, and with the addition of these classrooms the school is now one of the best appointed in the kingdom. The apparatus includes the practical teaching of chemistry and electricity. Benches for 24 boys, and tables for physical experiments, are fitted up, and in the adjoining room, in a laboratory for 110 pupils, practical demonstrations are given. Other rooms are fitted for manual training in carpentry and wood-turning. A swimming-bath and a gymnasium is also fitted in the school, which now occupies a unique position in physical instruction.

Electro-chemical Decoration.—A process has been brought out by Messrs. F. Krantz and H. Zeissler for the decoration of metal objects by electro-chemical means. The metal object is first painted over with bitumen, and the design is reproduced directly by means of a photographic negative proof, or is made in the ordinary way on the bitumen coating and developed with turpentine. The object is then placed in an acid biting bath, composed of two parts of nitric and one of concentrated sulphuric acid, with three parts of water. When sufficiently bitten it is taken out, washed well to remove every trace of acid, and rapidly dried in a warm place. It is then placed in an electroplating bath composed of the following parts by weight: 12 of cream of tartar, 1 of carbonate of copper, 24 of water. The bath for other metals is obtained by replacing the copper salt by a salt of the required metal, for instance, chloride of silver or gold, or the ordinary electroplating solutions.

The Institution.—Our remarks upon the Institution's connection with the Press had hardly reached some of our readers before we received a communication from the secretary making a new proposal. We have, after consultation with some of our colleagues, decided not to accept the offer of the Council. It may, and possibly will, prove to be the case that we stand somewhat alone in our refusal. The reasons for declining are founded upon principle—with which some of our colleagues are in accord, though preferring to let matters take their chance, knowing that the proposal is one that will fail of its own inherent weakness. We have taken the liberty of doubting if the proposal really emanated from the Council, but is not rather the suggestion of an interested paper. Because we have refused to agree with the proposal, our readers need not, however, fear that they will be deprived of any account of what goes on at the Institution. The unauthorised programme is sometimes more effective in bringing about reform than the authorised, and at any rate permits more freedom of speech. No doubt we shall be ostracised in some quarters, but that penalty we can bear.

Physical Society, Glasgow University.—The programme of papers for the session 1892-3 is as follows:

Nov. 4.—President's Address.—James H. Gray, M.A., B.Sc.
Nov. 11.—Communications by members.
Nov. 25.—Paper on "The Attractions of Elliptic Cylinders." George A. Gibson, M.A., F.R.S.E.
Dec. 16.—Paper on "The Thermo-electric Power of Platinum and Mercury."—Angus M'Lean, B.Sc., C.E.
Dec. 23.—Paper on "The Viscosity of Air."—J. R. Erskine Murray, B.Sc.
Jan. 13.—Paper on "Time—Ancient and Modern Computations."—Magnus Maclean, M.A., F.R.S.E.
Jan. 27.—Paper on "Portative Electric Energy."—J. T. Niblett.
Feb. 10.—"Further Notes from the Board of Trade Laboratory." J. Rennie, M.I.E.E.
Feb. 24.—Lecture on "Some Illustrations of the Development of Mechanical Tissues in Plants."—Prof. Bower, M.A., D.Sc., F.R.S.
Mar. 10.—Paper on "The Liquefaction of Gases."—J. Brownlee, M.A.
Mar. 24.—Ninth Annual Meeting.
April 14.—Paper on "Capacity and Insulation Tests."—A. W. Meikle, M.A.
April 28.—Paper on "Electrical Engineering Laboratories." J. D. Cormack, B.Sc., C.E.

Leclanche-Barbier Cells.—The latest type of Leclanche-Barbier cells, now being introduced into England, are made in both wet and dry forms. The wet form has a positive element consisting of a hollow cylindrical agglomerate of carbon and peroxide of manganese, having a metal ring cast round the upper part fitted with a wooden stopper, through which passes the zinc rod. The zinc is h-

in position in the centre by a rubber ring. The two elements thus attached are placed in the ammoniacal solution in a glass jar having a rubber washer round the mouth. The weight of the elements pressing on this automatically seals the joint; the cell is, therefore, a closed one, and there is no evaporation of liquid to the complete suppression of creeping salts, which is so troublesome in the ordinary form of Leclanché cells. The construction gives greater efficiency, decrease in internal resistance by absence of rubber bands, etc., and greater facility for access. The Leclanché dry cells now also introduced possess all the advantages of the Leclanché and Leclanché-Barbier wet batteries. Their electrical output and durability are equal to those of the wet pattern having the same sized positive elements. They are essentially composed of a Leclanché-Barbier hollow cylindrical agglomerate cemented into an outer zinc case by a composition which, in itself, contains the ammoniacal solution. This composition hardens sufficiently to prevent any contact between the agglomerate cylinder and the zinc casing, but it always retains a certain degree of dampness. The orifice of the cylinder is closed by a wooden stopper to prevent undue evaporation from the interior. When the strength of the current falls its full energy can be restored by removing the wooden stopper and filling the cylinder with saturated ammoniacal solution, a portion of which is absorbed by the agglomerate and the cement. Among the advantages of this dry form of battery are the absence of all liquids, the fact that it is supplied ready for immediate use, and that it will work efficiently in any position, and occupies less space than the wet battery of equal power; but above all the great superiority over other dry cells that when its electrical force is diminished it can be immediately restored to its full power by resaturating it with ammoniacal solution, and this without interfering with its quality of "dry" battery.

Popular Electrics.—The Belfast commissioner still continues his interesting and careful descriptions of the various electric stations. A recent article was given to the description, with graphic details, of the West Brompton station of the House-to-House Company; and in this we notice a new simile to explain the production of electrical energy that we have not seen before—namely, that of the winepress. "The smallness of the staff required to work this station," says the commissioner, "is greatly due to the fact that all the electricity pressed out of the dynamo is all gathered together in one spot, at the switchroom." The dynamo is, however, more like unto a force pump—there we have the nearest analogy; and to produce, store, control, and distribute the energy is the object of the electrical engineer. The commissioner finishes his above-mentioned article by a little joke that, as the Brompton station is situate between a railway and a cemetery, it certainly is "between the quick and the dead." A well-deserved compliment is paid to Mr. A. H. Wood for his lighting of the Wild West Exhibition. The commissioner next describes Bradford central station, and has interviewed the energetic electrical engineer-in-chief, Mr. Baynes, who explained the beauties and advantages of the low-tension system as adapted in the most satisfactory manner by the North Country municipality. Mr. W. T. McGowen, the venerable town clerk, informed him of the Council's immediate intention to spend £3,570 on extensions to meet the increasing demand, and also that the Council have awarded a contract for the lighting of Kirkgate Market for £1,440. The number of customers for electric light has amounted to 200, requiring 20,000 8-c.p. lamps. The demand has also steadily increased for electricity as a motive power, motors even up to 20 h.p. having been installed. These are used for hoists, lathes, coffee grinders, roasters, and various other purposes; while electroplating—a trade hitherto unknown in the town—has been started. The account is very interesting and encouraging, and must give great satisfaction to those inhabitants of Belfast who, desiring to progress and to have the benefits of electric supply, were yet timorous as to the advisability of saddling the town with the expense. The example of Bradford, and we may add St. Pancras—both municipal stations, and both highly successful—will aid very greatly in enabling other corporations to make up their minds upon the subject; and Belfast may well be grateful to its enterprising paper in furnishing them with such complete information upon the subject.

Liverpool Overhead Railway.—One of the greatest electrical enterprises yet undertaken in this country is about to be opened, in the shape of the overhead electrical railway in Liverpool. Running along the line of docks in one of the most important shipping ports of the world, this line will serve a multitude of interests, and in itself will prove the forerunner of many similar undertakings. The total length of the railway, from the Herculaneum Dock at the south end to the Hornby Dock at the north end, will be 5¾ miles; and the whole of this, except the small portion north of the Alexandra Dock, will, it is expected, be opened next month. The trains will traverse this distance for five miles, all stoppages included, in 25 minutes, and there will be a five-minute service during the chief part of the day—probably from eight in the morning to five in the evening. Trains will commence running in the morning at five o'clock and cease at half-past nine, a 10 minutes' service being run from 5 a.m. to 8 a.m. and from 5 p.m. to 9.30 p.m. There will be 13 stations at first, others being opened as needed. It is expected that the fare will be a uniform one of 2d. for any distance. No collectors or tickets being needed, the passengers will simply pay at the turnstiles at any station and alight where they desire for the one fare. The first car was safely placed on the lines on Monday. Two of these cars will make up a train. Each weighs 14 tons, is 45ft. long, and has accommodation for 56 passengers—first and second-class. The cars will be practically the same as those on the Manhattan elevated railway at New York, except that they will have side doors instead of end doors with an outside platform. There will be a passage from end to end of the car, seats for two persons, each running the whole length on both sides. There will be a motor and a driver's box at each end, so that the train will run either way without the necessity of shunting. The current for the motor will be fed on the third-rail system, as with the South London line. The generating station, which is under the Lancashire and Yorkshire Railway at the Bramley Moor Dock, contains four horizontal side-by-side compound engines, each of 400 i.h.p., and each driving an Elwell-Parker dynamo, by which the necessary electric current is generated. The steam power is supplied from six 30ft. by 8ft. Lancashire boilers, working at a pressure of 120lb. to the square inch, a complete condensing plant being provided. On Wednesday the Water-street Station of the electric railway was visited by H.H. the Maharajah Gaekwar of Baroda and suite, who were accompanied by the Mayor of Liverpool (Mr. J. De Bels Adam), and were received on behalf of the Overhead Railway Company by Mr. F. Fox (for the engineers), and Mr. S. B. Cottrell (resident engineer and general manager). Trial trips of the cars, which are being made in Wolverhampton, will be run during the next few weeks, and it is hoped that everything will be ready for the opening of the line before the end of next month.

Battle Search-Lights.—There was evidently something of great interest to occur at Ealing last Saturday. Crowds had gathered round Captain Ronald Scott's house and grounds, where bands, horsemen, and a notable group of special war correspondents were assembled to take part in a battle by electric light. At 4.30 p.m. the 4th Middlesex West London Rifle Volunteers paraded in Ealing Broadway 350 strong, commanded by Colonel Somers Lewes. Arrangements had been made to have a sham battle on Horsenden-hill, and a company under Major Hopkins represented the enemy, the great object being to test the efficacy of the search-light projector in active field service. Captain Scott, who is an officer in the 4th Middlesex, had the management of the search-light in the hands of some of his assistants, and the experiments served to show that projectors need not be confined to stationary positions, but might be taken wherever artillery could be taken. The current was obtained from a set of accumulators, and a specially-designed carriage with broad tyres is to be used. On the eventful night, shortly before six, Major Riddell began the advance from Perivale Church. The difficult point was the bridge, and if the enemy could get past the day would be gained. The defenders, however, had all the latest resources of science at their command and the great search light flashing upon the ranks of the enemy revealed the brightly-illuminated forms of the grey-coated company. In actual war they would have been easy mark for fire. The light was flashed a little too soon for surety, and the enemy retired and took up a second line, but again were blinded by the glare of light from the projector, and stormed by rifle volleys. The defenders fell back and gave the attackers a chance to rush the bridge, when the light was turned on a mass of struggling human beings, and probably not half would have got over alive. However, the weight of numbers told, and when "cease fire" sounded the advantage was supposed to be in favour of the attack. But Captain Scott had proved beyond doubt the efficacy of his projector to the great delight of the numerous spectators and the satisfaction of the military men present. The battalion marched back to The Elms, Acton, where Captain Scott entertained his visitors. Experiments were then made with cloud writing by electric light. Words were projected upon the trees, buildings, and artificial clouds of steam. The face of Mr Gladstone was received with applause, and names of well-known advertisers were cast upon the clouds. Spectators could read clearly words thrown from the projector on the roof to distant belts of trees. The idea in these experiments is that, not alone for advertisement but for actual signalling in war, luminous letters and words might be satisfactorily employed. Captain Ronald Scott is to be congratulated upon the success of his initiative, and the great interest he has aroused in this use of the electric light. Captain Scott was ably assisted in his experiments by three of his works staff, Messrs. Tyson, Gibbons, and Edgelow.

The Lecturing Season.—When November fogs begin to fill the London skies, then is the time that the lecturer and the reader of scientific papers begins his serious work. The scope is widening. We have no longer alone the institution and the popular scientific papers, but we have the county council and the workshop lectures. No meagre field, these latter, for the budding aspirations of a coming man, and the audiences are inspiriting, which is not always the case with your real scientific audience, for those who attend are wishful of knowledge and bent upon using it. And there are reputations to be made in workshop lectures. Did not Dr. Fleming flesh his blade at Crompton's factory? His workshop lectures are still amongst the best he has done, and have proved an incentive to more than one good man. Other firms, from time to time, have followed this lead. It is now the time for directors, proprietors, and engineers-in-chief to consider the needs of their workmen and themselves. Many a worse move has been made than that of giving workshop lectures. Who knows, too, that besides the better knowledge of theory resultant therefrom, a budding Gramme, Kapp, or Ferranti may not come forth under the stimulus. We are yet not flush of good designers in the electrical world. Perhaps, after all, the greatly-felt need for lecturers who will lecture upon practical work is but an effect from the want of good text books. How clear and inspiriting a good lecture, how difficult to comprehend a book. The earnestest student must twist and turn his book, turn this way and that, and read over and over again for weeks before he masters his text-book. Did it not take Thackeray three months to read through a primer on chemistry? Possibly, nay probably, is this because no one has really discovered how to arrange a text-book in the truly logical fashion; a new kind of scientific text-book is badly needed, one based upon the idea that the reader need not, like the author, jump from here to there like a knight on a chessboard, but might read right through, and reading, understand. This "here and there" arrangement of facts and arguments is also, too often, the fault of the scientific paper. There are one or two offenders in this respect at our own institution. No one can tell for some minutes after the first break away of every paragraph, whither exactly the author is driving to; there is a curious crookedness about what in logic is termed the "dialectic" of their thoughts. Too often it is forgotten that the use of words by a speaker is simply to call up ideas, actual pictures, in a logical sequence in the mind of the hearer, and that the unity of scene of these ideas must be kept for the time being if the hearer is fully to understand. The greatest interest in a scientific subject will sometimes yield to listlessness and even petulancy if the writer of the paper have not mastered the elementary laws which regulate literary form. Science progresses, but it must go hand in hand with literature if its exponents are not merely to rest dumb artificers. In scientific theatre, hall, classroom, and workshop there is scope for advance, and the coming season should receive its advance in style as well as in scientific achievement.

Mansion Lighting in Scotland.—The following interesting account of a Perthshire mansion lighted by electricity is given in the *Dundee Advertiser*. "The base of Schiehallion, one would imagine, is not the likeliest place to look for the introduction of the newest appliances in connection with the electric light. Yet it is so. Mr. Bunten has just had the mansion-house on his beautiful estate of Dunalistair lit by electricity. Shortly after he became proprietor of the estate in May, 1891, he resolved to introduce the electric light. As Dunalistair is fully 10 miles from a railway station, and as the price of coal is necessarily high—between 30s. and 40s. a ton—the cost of driving the dynamo by steam power would have been very expensive. But Mr. Bunten soon saw that he had an efficient and a less expensive motive power ready to hand in the water which flows freely down the sides of Schiehallion, and he resolved to utilise it. The contents of three burns are discharged into a dam fully three-quarters of a mile from the mansion-house. The dam, which covers about a rood of ground, and is 14ft. deep, is fitted up with a filter bank to keep back the sand. From the dam the water is conveyed about 500 yards in 10in. iron pipes to the dynamo-house, which is situated on the banks of the Tummel, beside the woollen

bridge which connects Dunalistair and Crossmount. To accommodate the engineer and the necessary machinery, a model cottage has been erected. On the ground floor there is kitchen, scullery, and pantry on the one side, with dynamo-room on the other, while upstairs there are two bedrooms, pantry, bath, etc. In the dynamo-room, which measures 18ft. by 14ft., there are two turbines and two dynamos. The turbines are 12½ h.p. each, and arrangements are made so that one turbine and one machine can run, or the two together, if required. The dynamos are the Edison-Hopkinson patent, and were manufactured by Messrs. Mather and Platt. The current is led by two conductors from the dynamos to the mansion-house, a distance of between 400 and 500 yards, and there are branches from the house to the stables and laundry, about 200 yards beyond. The premises are fitted up on the distributing system with fully 300 lamps. With the exception of one Sunbeam lamp of 150 c.p. in the stable yard and 18 lamps of 5 c.p. each in the billiard-room, all the lamps are Edison-Swans of 16 c.p. each. In the roof of the dining-room a crystal bracket is fitted up with eight lamps, and by an arrangement of two switches either four or eight can be used as desired. Sockets have been fitted up throughout the room for portable lamps. In the library there is a crystal bracket with four lamps and a number of sockets. There are eight lamps in the front hall, six on the main staircase, five in the smoking-room, while in the billiard-room, besides the 18 lamps already mentioned, there are a number of side brackets. All the bedrooms are lit with adjustable crystal pendants, and besides there are sockets for portable lamps. The adjustable lights above the mirrors in the bedrooms are quite a new feature. Numerous lights have been fitted up in the passages and corridors. There are seventeen in the stable, five in the laundry, and eight in the dynamo-room and dwelling-house, beside one at the front door to light the bridge of the road. Messrs. Mavor and Coulson, Glasgow, fitted up the electric plant, while the turbines were supplied by Messrs. Silkes and Co., Kendal. The whole of the work was designed and carried out under the superintendence of Mr. Angus Murray, of the Anderson Foundry, Glasgow. Since the installation was effected everything has wrought most satisfactorily, and the light Mr. Bunten says he has found to make all the difference between comfort and discomfort in a country house in the dark wintry nights. The cost, including the price of the cottage, amounted to close on £3,000. By adopting water as a motive power the necessity for accumulators is entirely dispensed with, and an immense saving of money is effected. The capacity of the wires is sufficient to carry double the number of lights that have been fitted up.

Lithanode.—It is very interesting to watch the gradual development of a business from small attempts to greater and greater flights. A material is invented, like Mr. FitzGerald's lithanode, which has most if not all of the qualities which are required for an electric accumulator—solidity, lightness, great capacity; it is employed at first for a few portable batteries—we remember the little plates made in our presence a year or so ago, when we first drew the attention of electrical engineers practically to Mr. FitzGerald's inventions. Since then great strides have been made in the practical organisation of the business. Mr. J. T. Niblett, one of Lord Kelvin's old assistants, an exceedingly capable electrical engineer and organiser, has put his energies into the practical part of the business, and it is not too much to say that lithanode promises to become a standard article for electrical needs. We have the catalogue of the Lithanode and General Electric Company before us, which illustrates the present position of these batteries. Made from compressed protoxide of lead, with a chemical to make the spongy mass set solid, the lithanode can be formed of various qualities to give greater or less proportion of peroxide, the usual proportion being between 80 and 90 per cent. A non-oxidisable metal, platinum or gilded lead, is used for conductor, and with this arrangementan element is obtained practically free from local action, and one which will retain its charge for a long time, even when partly discharged and left in solution. The great advantages are large capacity for weight of material and solidity of plate, both advantages making lithanode particularly useful for portable batteries as cells for miners' lamps and for accumulator traction. Larger-sized cells are made of the Frankland-Lithanode type, blocks of lithanode being cast round with melted lead. Stock patterns of these are made with capacities ranging from 30 to 600 ampere-hours, capable of discharging at rates from 5 to 100 amperes, making batteries very suitable for private installation use. A special cell for station work is now being made, and will be capable of discharging at the rate of 1,000 amperes for a period of one hour without appreciable fall of potential. Where special lightness is required, the negative element is formed by compressing lithanode upon a double network of copper gauze, and an element is obtained of great strength and but half the weight of ordinary negative plate, giving a net gain of some 20 per cent. in the whole cell—no mean advantage for transport work. Great attention has been paid by the Lithanode Company to portable lamps, and a number of adaptations are to be seen at their showroom and works at 64, Millbank-street, Westminster. An extremely handy form of portable reading lamp, made in 2, 3, 4, and 5 cell sizes for runs of two to eight hours has a detachable lamp for use in the buttonhole for railway travelling; it can also be affixed to the battery in an upright or horizontal position, making a simple hand lamp or a lecturer's reading lamp, as desired. Fitted with non-actinic glass, it has been much appreciated by photographers for dark-room work. A smaller lamp with two cells in flat form will slip entire into an ordinary pocket; it has been much used by policemen, omnibus and tramcar conductors. A great future for these lithanode cells and lamps is for omnibus, car, and train lighting. Being small and solid, the cells can be easily and safely handled, and already many of the London omnibuses are so lighted by the Lithanode Company's cells with extremely satisfactory results. The lithanode cells have made themselves a special name in two important fields—namely, for miners' lamps and for theatre stage work. Miners' lamps are made in two sizes, weighing 4½lb. and 3½lb. respectively, steel-plate coated and strongly made. They have been well tested and have proved their usefulness. For stage work a number of specially light cells have been made for the fairies to wear on their backs, lighting a luminous star on the forehead. At the Crystal Palace pantomime these electric stars were used with very handsome effect. The Lithanode Company also make a small testing cell of zinc and lithanode a few inches high, with a potential of nearly 2½ volts each, which have been found extremely useful for making up testing sets. With 500 of these little cells an available pressure of over 1,000 volts is always at disposal for testing purposes, and the whole set goes into a moderate-sized cupboard. Such a set is illustrated in the catalogue. The company accept contracts on a maintenance basis, and as the merits of their wares are more widely known we may confidently expect continued increase of the usefulness of the lithanode.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC.MEM.INST. ELECTRICAL ENGINEERS.

IV.—GAS AND OIL ENGINES.

(Continued from page 433.)

Ignition Tube.—The gaseous mixture is fired in the modern gas engine by means of an ignition tube, and the following account will explain how it is done: The tube is a short piece of ordinary wrought-iron gas piping, ⅜in. to ½in. diameter and about 7½in. long, the top end of the tube being closed. The tube is placed over the flame of a Bunsen burner, and so made red hot, the lining of the chimney covering the tube, consisting of asbestos. The top of the chimney is closed by a perforated cover, so as to prevent any dust or foreign matter falling in; a tap regulates the amount of gas in the Bunsen burner, and in practice this tap must be adjusted so that the tube attains a cherry red heat, which can easily be seen by glancing down the chimney, and on no account must this degree of heat be altered. Any excess will quickly burn out the tube, which signifies stoppage of the engine. A caution must here be given not to look down the chimney more than necessary, and to do so quickly, since when a tube gives serious injury to the sight would result to anyone caught. Passage between the ignition tube and the interior of the cylinder is opened and shut by the movement of an ignition valve, this valve being operated by a lever, which is acted upon by a double cam on the screw shaft. When the piston is compressing the mixture, it is necessary that the communication between the cylinder and the ignition tube should be cut off, therefore the lever lifts the ignition valve, which enters an aperture, thus effectively closing the passage. To provide for any leakage of gas that may take place from the cylinder, a hole allows it to escape into the atmosphere. When the compression is finished, the cam allows the lever to drop, hence the valve drops on to its seat; the passage is now open, so that a quantity of the compressed gas from the cylinder rushes through into the hot tube, which ignites it at once; the burning gas being forced back re-enters the cylinder and ignites the compressed charge. Two chambers are for the purpose of receiving the burnt products of the gas which fires the charge, to avoid as much as possible any choking up of the passages by residuum, etc.

Life of Tubes.—The ordinary wrought-iron gas tube may be reckoned to last 30 hours, but this is not guaranteed, for some only last a few hours; on the other hand, some may last 60 hours. In running, it is advisable to change them every 24 hours of actual work. If the gas engine is not doing any particular work, when stopping would not signify much, such as charging accumulators in the daytime, etc., then the tube might be left in until it burnt out. Lately, Messrs. Crossley have put on the market a greatly improved tube; it is made of steel with some alloy, the exact composition of which is kept secret, and they will last twelve months. Concerning these tubes, the author has just been informed by Messrs. Crossley that one of their customers brought them a tube which had been in use from January to October, and was still in good condition after working 10 hours per day. The superiority and advantages of these prepared steel tubes over the wrought-iron tubes is thus evident. For it causes great inconvenience and annoyance when the electric light goes out suddenly through the failure of the ignition tube. The cost of these steel tubes is high, 12s. 6d. each, and 15s. with holder, whereas the iron ones are only 2½d. each; in addition, the steel tubes must be handled with great care, as they are extremely fragile, and the slightest knock would fracture them. But, as said before, where it is of great importance for the gas engine to run without danger of stopping, the high cost of the steel tubes is a trifle in comparison.

Steady Running, etc.—The latest and most improved form of Crossley's high-speed gas engine for electric lighting is fitted with their patent controlled tube ignition. These engines give a most remarkable steady drive, equal to a steam engine; this is owing to the two very heavy wheels on the engine, either of which can be used as a driving wheel; these wheels are also loaded with a mass of metal near their axis. Another reason for their steadiness is their high speed—250 revolutions per minute—so that two such heavy wheels rotating at this speed possess an enormous amount of momentum, and, therefore, the explosion of the charge does not tend to jerk the speed.

Governors.—A gas engine consumes gas exactly in proportion to the load, and this is effected by the aid of a governor. In the case of the above type, in the screw shaft, which works the valves, there is another cam, having three grooves cut in it—each groove promoting a different action. The governor as it rises and falls in response to the load actuates a lever which shifts to and fro, shifting a wheel into one of the grooves, and thus the revolving cam moves the lever to a greater or less extent. This movement of the lever works the admission valve, a strong spring attached to the lever tending to hold the lever down, and so keeps the valve closed when the cam is not acting. By this arrangement the amount of gas admitted into the cylinder is in proportion to the power developed.

In Tabulation 11, given below, the results of running costs, as calculated out for steam and gas engines, are collected together, so that the difference existing between the two can be seen at a glance. The large steam engine gives 40 b.h.p., and the large gas engine gives 35 b.h.p., these two sizes being sufficiently near for comparison; same with regard to the small engines, where the steam engine is 10 b.h.p. and the gas engine 9 b.h.p. The columns denoted by A give the price of 1 b.h.p. per annum, whilst the columns denoted by B give the price of 1 b.h.p. per hour in pence.

TABULATION 11.

Large Plant.

Hours per annum.	Steam A.	Steam B.	Gas A.	Gas B.
3,000	£10 0 0	·800 or [illegible]	£10 16 7	·86 [illegible]
1,500	7 10 0	1·200 or 1¼	6 4 1	1 [illegible]
750	6 5 0	2·0 or 2	3 17 10	1·24 [illegible]

Small Plant.

Hours per annum.	Steam A.	Steam B.	Gas A.	Gas B.
3,000	£19 11 0	1·56 or 1½	£16 12 8	1·31 [illegible]
1,500	16 8 6	2·60 or 3	10 8 10	1·6 [illegible]
750	14 7 3	4·75 or 4¾	7 6 10	2·[illegible]

Some interesting results are shown by this tabulation. It will be noticed that when running for 3,000 hours per annum the steam engine and gas engine are about on a level for cost, and that as the running hours are shortened so the cost of a gas engine becomes less than that of a steam engine. Coming to the smaller plant, we see that gas has a most decided advantage, even for long hours, and for short hours it is only half the cost of steam. We are thus led to the following conclusion:

With engines of about 40 b.h.p. running 3,000 hours, the cost for steam and gas are about equal;

As the power decreases, so gas will be less than steam.
As the power increases, so steam will be less than gas.
As the hours decrease, so gas will be less than steam.
As the hours increase, so steam will be less than gas.

Dowson and other Gas Producers.—A gas producer is an apparatus for manufacturing explosive gas or vapour. The fuel used may be divided into two classes: (1) coal, wood, etc.; (2) petroleum and other oils, fats, etc.

The best known gas producer used for generating gas for driving gas engines is Dowson's, the gas produced being named Dowson gas. This gas is made in the following way: Coal, or other suitable fuel, is burnt in a steam producer, the steam is mixed with air, and the mixture forced through an incandescent mass of burning fuel placed in the generator. The steam is decomposed into its constituent parts—namely, hydrogen and oxygen. The hydrogen passes

off, while the oxygen from the steam and from the air combines with the carbon to form carbonic acid gas (CO_2), this afterwards, mixing with more carbon, becomes reduced to carbon monoxide (CO), so that the gas produced consists of carbon monoxide, together with hydrogen, and small quantities of CO_2, nitrogen from the air being present in large quantities. Owing to the large quantity of carbon monoxide gas that is contained in Dowson gas, this gas must be used with great caution, since CO is a deadly poison, and an atmosphere containing, say, 2 per cent. of it would endanger life. The plant, however, is made very secure, and although used a great deal very few fatalities have occurred.

The heat of combustion of Dowson gas is one quarter of that given by an equal volume of coal gas, consequently four times as much is required to drive gas engines, so that where 20 cubic feet of coal gas is consumed per brake horse-power, more than 80 cubic feet of Dowson gas is required. The plant takes up very little room, and gas is manufactured at a very rapid rate. For example, a ground space of about 10ft. square would accommodate a plant sufficiently powerful to supply gas to a gas engine giving 45 b.h.p. Comparing this with the space a steam boiler takes, it is about on a par.

From tests which have been made, it is found that using coal to produce Dowson gas to drive a gas engine, only 1·3lb. of coal are consumed per brake horse-power per hour. This test was for an engine giving 7 b.h.p. A more recent test, where a Crossley Otto gas engine developing 170 i.h.p. was driven by Dowson gas, gave a consumption of coal of ·883lb. per indicated horse-power hour, and only 52lb. of water for everything—a most astonishing performance; this works out to ·08, or about $\frac{1}{12}$ of a penny per brake horse-power hour, using coal at 15s. per ton.

As an example of gas made from oils, fats, etc., we will take Mansfield's oil-gas apparatus. In this apparatus, the oil, or fatty matter, is vaporised in a retort heated by a fire of coal, wood, or other suitable fuel; the gas given off is passed through water to abstract all tar products, and is then purified by being passed over a mixture of slaked lime and sawdust. The kind of oils mostly used are those known as "intermediate," they have no unpleasant smell. It is found that 1,000 cubic feet of gas can be made from 10 gallons of oil, or one gallon will supply 100 cubic feet of gas. For large-sized gas engines the consumption of oil gas may be taken as about 10 cubic feet per brake horse-power per hour. Oil costs, say, 4½d. per gallon, and the cost of fuel in the furnace is about 1d. per 100 cubic feet of gas produced, and since one gallon will produce 100 cubic feet, hence total cost will be 5½d., or, say, 6d. per 100 cubic feet, allowing 10 cubic feet for 1 b.h.p., this comes to ·6, or ⅗ of a penny per brake horse-power per hour.

Petroleum Oil Engines.—Of late years petroleum oil has provided a most important and extensive source of fuel, and entirely supplies the place of coal in districts where that fuel is scarce and oil is plentiful, and every year this oil becomes more used. In South Russia, where the greatest petroleum wells in the world exist, the refuse of this oil is used in the place of coal in the furnace of the locomotives, the oil being stored in an oil-tank for the purpose, and is also used for steamers; 1lb. of petroleum oil will give out 50 per cent. more heat energy than 1lb. of coal, so that to give the same heat energy, oil fuel is 33 per cent. less in weight than coal fuel. In addition, it only occupies about one-half the bulk that coal does.

Another way of using petroleum for motive power is by vaporising it, and then exploding the oil gas, as in Mansfield oil-gas producers. But there is also a third way, and this is, perhaps, the most important, or at all events will become so, in every probability; this is by using the oil both as a fuel and motive force in the cylinder of the engine. This is illustrated by Priestman's petroleum oil engine.

The engine is very compact and entirely self-contained. The foundation of the engine contains a water-tank, supplying water to the cylinder jacket; this does away with a separate tank and piping. Underneath the engine, by the crank, is situated the oil-tank, the oil for a day's run being usually put in, while under the cylinder is placed the vaporiser; a side shaft works two pumps, the larger one being for compressing air, and the smaller one for circulating water round the cylinder. The working of the engine is as follows: the air pump forces air at a pressure of about 7lb. per square inch on top of the oil; a stream of oil is then forced along a pipe, and another stream of air along another pipe; both join and lead into the vaporiser, and then the air breaks the oil into a spray; whilst passing through the vaporiser the mixture of oil and air is heated by the exhaust gases from the cylinder. As the piston makes its forward stroke, it sucks in after it, by means of a suction valve, a quantity of oil spray and air. After compression this mixture is fired by an electric spark. The wires from an induction coil are led into the cylinder, the spark jumping across the gap between the two wires; the electric circuit is closed by the side shaft moving backwards and forwards, and so bridging across the two terminals, by means of a contact-piece. The burnt gases driven out by the exhaust port are utilised in heating the mixture passing through the vaporiser. The oil, when exploding, has the valuable property of lubricating the piston. Common petroleum oil is used, which can be obtained almost anywhere; this oil is particularly cheap in seaport towns, therefore oil engines should thrive in those places; an average price is 5½d. per gallon.

The amount of oil required to produce 1 b.h.p. per hour is proved to be less than 1¼ pints of oil; this will cost therefore ·86d., or ⅞d. One gallon of common petroleum oil, specific gravity ·800, weighs about 8lb. And since 1lb. of petroleum is equivalent to 1½lb. of coal in heat energy, therefore 1¼ pints of oil $= 1\frac{1}{4} \times 1\frac{1}{2} = 1·9$, or nearly 2lb. of coal; this is equal to $14,500 \times 2 = 29,000$ heat units to produce 1 b.h.p. per hour. So that the efficiency of the oil engine is about equal to the very best steam engine, as it utilises about 10 per cent. of the heat energy of the oil, and has half the efficiency of the gas engine using 22·5 cubic feet of gas per hour.

The way to start the Priestman oil engine is the following: First, the vaporiser must be heated by means of a hand oil lamp (a few minutes suffice for this) like heating the ignition tube of a gas engine. The air pump is then worked by hand by a lever for that purpose placed at the crank end of the engine (half-a-dozen strokes is sufficient for this), two or three turns of the flywheel, a couple of explosions, and the engine is off.

Common petroleum or lamp oil is perfectly safe to store and handle, since if a lighted match be dropped into a vessel full of this oil the oil will neither explode or burn, and the light will be quenched as if it had fallen into water.

The following tabulation gives the efficiency and cost of fuel per brake horse-power per hour for different motors:

TABULATION 12.

Motor.	Fuel.	Per B.H.P. per hour.	Heat units.	Efficiency.	Cost B.H.P. per hour.
Steam.	Coal.	4lb.	58,000	4·5%	·32 penny.
Gas.	Gas.	22·5 cub. ft.	15,000	17·2%	·75 ,,
Oil.	Oil.	1·25 pints.	27,550	9·3%	·86 ,,

Coal being at 15s. per ton, gas at 2s. 9d. per 1,000 cubic feet, and oil at 5½d. per gallon.

(To be continued.)

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.*

BY PROF. GEORGE FORBES.

LECTURE IV.

(Concluded from page 436.)

I will now speak a few words about the best arrangement of destructors which I have ever seen up to the present time, and that is one of the destructors which are used at Leeds. In 1878 the Corporation began, in an experimental way, with six cells at Burmantofts; in 1879, six more were put up at Armley-road; in 1882, four more cells at each of these places; in 1887, two more cells were put up at Armley-road, and in 1890 they built 10 new cells

* Cantor Lectures delivered before the Society of Arts.

at Kidacre-street. Thus, you see, Leeds has been steadily progressing. The first work was purely experimental, but they were thoroughly satisfied with the experiments, and they proceeded to continue the same work. At every step they have seen some improvement which could be introduced, and even at this present moment in connection with what I have just spoken of as the best destructor in existence, they are just going to put down a new destructor, and are totally going to introduce some new improvements. Here again they are going to have experimental work, and see how it does, and if it succeeds, as I think there is little doubt it will, they will proceed to build destructors on the improved plan. In these old destructors some steam was got up to drive a mortar-mill, the clinker being used to make the mortar of, and a considerable amount they have been able to sell. This clinker is always a source of trouble; one-fourth of the weight of the fuel is given back in that form. You cannot be burning iron pots and crockery without getting a certain amount of slag from it; nevertheless, it is found to be the cheapest way simply to put the whole stuff in as it comes from the ash pits, and burn everything, whether it is combustible or not, if I may use the expression. Consequently there is a large amount of slag, but this slag can be broken up and used for mortar, and it makes admirable mortar. It can also be used for road beds, road foundations, and ballasting, and when powdered and mixed with cement it can be made into artificial stones and paving slabs. The labour at each of these Leeds destructors is one foreman and engine driver, six furnace men, and one labourer. The whole place is perfectly clean, and kept in regular working order. Every pair of cells is charged every 25 minutes; they are banked at 1 p.m. on Saturday until midnight on Sunday. The damper to the boiler flue is closed at 7 p.m. on Saturdays. Everything is perfectly methodical. The fuel is carted in up an inclined road over a platform, and tipped upon the platform on the top of the destructor. In the diagram shown here of the Kidacre-street destructor, Fig. 2 (which I am able to give you through the kindness of the ...neer, Mr. Hewson, who has let me have the actual plans which were used in the construction), you will see that half the section shows the furnace, and the other half shows the cell flue, which is parallel to the furnace and intermediate between every two furnaces. You will recognise some resemblance to the Fryer destructor in this arrangement. The gases, however, before leaving the furnace, pass over the hottest part of the fire, and leave by a hole at the side of the furnace—marked cell flue in the left-hand section, and also shown in the right-hand section—thence passing along one of the cell flues into the champion flue, whence they pass on, it may be by the boilers, it may be by a by-pass to the chimney. This is the most important improvement that has been introduced by Mr. Hewson. Another great improvement on the old destructors is the addition of a forced draught. Instead of using a blowing engine, as they had plenty of steam from boilers which they did not want to use in any other way, to avoid having a steam engine to work, they have [illegible] the steam directly through a jet and through a funnel-shaped aperture (shown underneath the firebars), the jet of steam drawing air in through it, which passes through the firebars, and produces a fierce draught, thereby giving very much greater heat, and enabling us to burn a very much greater quantity of material in a given time. Five furnaces are on one side of the destructor, and there are five others behind these, and the cell flues in the middle between. The steam coming from the boilers is led to the funnel-shaped inlets for the air. The firebars are herring-bone shaped, and are capable of being rocked up and down by means of a handle, thus facilitating the disengagement of the clinker.

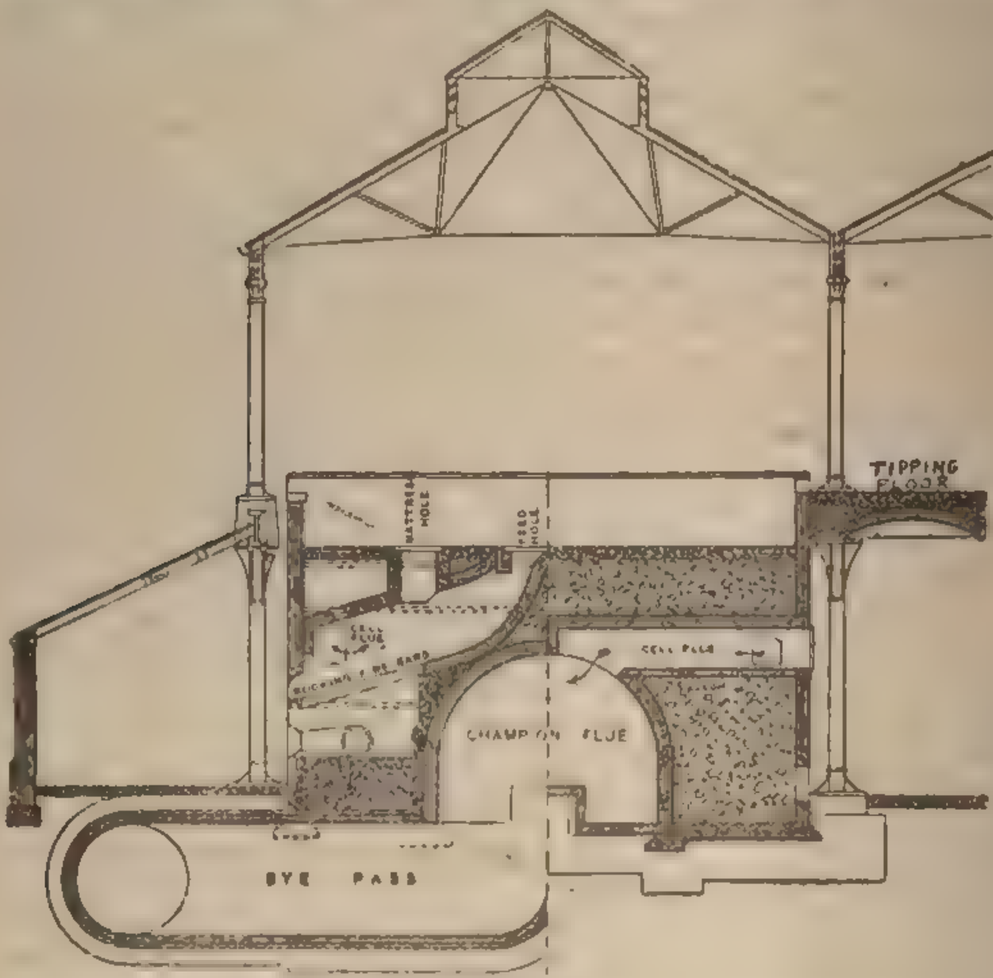

Fig. 2.

During a single year, up to 1886—that is, before the new destructor was built at Leeds—there were 20 cells, which burnt 35,248 tons of refuse. We may generally assume that each furnace is capable of burning about 34 tons a week. The refuse contains ordinary ashbin refuse along with trade and market refuse. Therefore, in addition to what I have mentioned as being found at Paddington, there was market refuse and other material of that sort, among which I may mention some totally different things

There were 11 cows burnt, 3 calves, 17 sheep, 4 goats, 298 pigs, 5 turkeys, 2 carcases of beef, 28 quarters of beef, 9cwt. of pork, 10cwt. of pickled tongues, 12cwt. herrings, 218cwt. shell fish, 1cwt. sugar, 285 dogs, 109 cats, 13 foxes, 1 sea serpent, 147 mattresses, beds, pillows, and bolsters, 7 blankets, quilts, and sheets, 36 pieces of carpet, 7 hearthrugs and mats, 33 pieces of clothing, 1 bedstead, 1 sofa, 1 chair, 1 bundle of rags. It is something to say that, without any complaint, the destructors at the high temperature at which they work were able to destroy all these objectionable things, which have been found so difficult to get rid of in any other way. The cost of working these furnaces for this one year before the new one were introduced was: For wages, £1,162; coal, oil, water, tallow, and gas, £181; implements and repairs, 227; rates, taxes, and insurance, £153; lime, for the mortar making, £78; total cost, £1,801; less mortar and old iron, which was sold, £395; leaving the total cost £1,406. Or, including interest, etc., a cost of 1s. 3d. a ton for destroying refuse. This is less than it would have cost to cart away the material and dump it, besides being, of course, far less objectionable, and the only healthy way of disposing of the refuse. The Leeds destructors which are going to be put up in the immediate future, have several improvements in the matter of more area; in the matter of washing smoke, to get rid of dust and other objectionable particles that go up the chimney; and the most startling and most efficient idea of automatic feeding. Mr. Hewson tells me that he has the intention of having the firebars formed in one continuous feeding belt, going along the whole range of the furnaces, the fuel being fed in at one end and carried along over one continuous furnace, being gradually burnt as it travels along. I am sure, judging by the success that Mr. Hewson has had in his past experiments with destructors, what he is going to do now will be very successful; and the smoke washing he has introduced is a plan which has proved to be the most successful mode of getting rid of smoke which has occurred to me.

Various tests have been made of destructors by pyrometers in Leeds. The temperature of the gases at the east end of the furnaces at Burmantofts was over 1,500deg. F.; at the west end, between the furnaces and the chimney stack, 1,150deg.; at the bottom of the chimney stack, 875deg., the furnaces being fed with air by an arrangement of steam jets, different to that in the new destructor, where they are considerably better arranged than has ever been the case before in the manner I have already described to you, the rapidity of burning being very much greater, and the temperature much higher. Dr Spottiswoode Cameron, medical officer to the Corporation, has given me valuable information in connection with the destructors. He has gone into these questions of the temperature and analyses of the gases, and he tells me that his experience is that the temperature measured with the pyrometer is very much a function of the observer, but they have had most careful men for measuring these temperatures, and in the new destructor the pyrometers do not read over 1,500deg. They are not capable of reading high enough temperatures to read the temperatures in this destructor, so that really during a great portion of the time the temperature is over 1,500deg. Mr. Alderman Ward has given some details of some tests which were made with the steam jets, and without the steam jets in this new destructor. The effect was, that while the steam jets were not in action the average temperature was 1,118deg., while the steam jets were in action the average measured was 1,464deg., but in a number of cases the temperature was higher than the 1,500deg. registered, because the pyrometer would not register more, so that you may be sure that the real average was over 1,500deg. Without the jets 6·2 tons were burnt in each cell per day; with the jets 6·7 tons per day. This is a marked improvement over the old experiments made in former times. Mr. Thomas Codrington, who made such an admirable report to the Local Government Board some years ago on furnaces, estimated the average temperature as follows for different places: In the Whitechapel district, 180deg. to 1,000deg., the average of eight cells being 490deg. At Ealing he found 855deg., 520deg., and 520deg. At Bradford, in the main flue, the temperature was 415deg. So that there is no doubt that in the Leeds destructor we have a much more valuable result, and it only remains to arrange for generating the steam in a proper manner to get a really good result. The residuary gases have been tested at Burmantofts, and the proportion in every 100 parts is: of air 81·67, carbonic acid 4·0, carbonic oxide 0·16, nitrogen 14·17.

Now, I could have given you a great many more facts about destructors which would have been very interesting, but I think I have said enough to show you that they will play a most enormous part in the industrial lighting of the future, and, at any rate, that the concluding subject of this course of lectures which I have delivered you is one of the most promising lines for engineers to study and develop as far as in them lies.

With regard to the other details of the lectures which I have drawn special attention to, I should just wish, in conclusion, to repeat to you one or two points to which I drew attention earlier. First, I wish to reiterate the fact that in large central station works on the alternating-current system, the plan which must recommend itself to engineers of the present day is to depart from the old plan, and to use low-tension secondary mains all over the district that is to be supplied; to have subsidiary stations with large transformers in them, with attendants to regulate them if necessary, or else automatic means of regulating them, so that we may have our machinery always at work at an efficient rate; and last, but by no means least, when we come to work in this way, and to put transformers into sub-stations, that probably the most efficient way will be to use alternations of much lower frequency than anything we have been dreaming of in the past; and for my own part I shall watch with interest to see what manufacturers will do when they see that this is the line on which work must be done. It will be interesting to see whether manufacturers will be ready to supply the machinery required for low frequency when that demand comes, as it undoubtedly must come in the immediate future. Low frequency is not only an advantage because large thick secondary mains can carry currents of low frequency efficiently, while they cannot carry currents of high frequency efficiently, but also because the currents of low frequency will be directly available for motors; and although I prefer to have motors on a separate circuit, there is no objection to using light motors, never going over 1 h.p. or so, on the lighting circuits; and for that purpose the low-frequency current will supply us with a solution of the problem immediately. We shall also be able to rectify the current, so as to use these slowly-alternating currents for charging storage batteries or to perform other electro-chemical operations. For all these purposes I have no hesitation in saying that that is the best means of modifying the existing practice in connection with alternate-current central station work.

With regard to continuous currents, and central station work at low pressures, all I have to say is that although I cannot see at the present moment that actual economy is introduced by the employment of accumulators in central stations, still they have an enormous convenience, and if they can be reduced in price they will be largely used for taking up part of the work at slack times, and also for taking up part of the work during the maximum output. At present, I cannot see that there is any economy in these two things. It is cheaper to generate your current direct, by means of a steam engine and dynamos, for these two purposes. But the value of accumulators is for regulating the pressure which you are to supply to your feeders; and so enormously important is it that something of that sort must always be used in central stations, that I have only to say that, in the operation, where you do not want to have a very large discharge of current for overcoming a breakdown in your machinery, if you are sufficiently satisfied with your machinery not to expect a breakdown, I would not use then the expensively made up accumulators. I would use nothing but simple plates of lead cut into a definite shape, without putting any oxide into them, or without any previous preparation of the lead, and without paying royalties for any patent rights. I would use the old Planté battery pure and simple, in the cheapest form in which it can be made.

I think these are the only points which I have mentioned in my lectures to which I wished to draw your particular attention, and I hope I may not find that I have made any mistake in drawing attention to these, as points which would deserve very great attention at the present moment

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GEORGE WESTINGHOUSE, JUN., ON "NINETY MILES AN HOUR."

My attention has recently been called to an article relative to brakes and high-speed trains in which I was quoted as the authority. In consequence of the errors in the article referred to, and the importance of the questions raised, I desire, through your columns, to state some important facts bearing upon the subject, to which I am sure railroad officers will give careful consideration.

By referring to the celebrated Douglas Galton brake experiments it will be seen that, with the brakes in the best possible order, acting upon all of the wheels of one vehicle and up to their theoretical efficiency, it was only possible to reduce the speed at the rate of about 3½ miles per hour for each second the brakes were applied until the vehicle stopped; and it was further found, during these experiments, that the higher the speed the less the brake-shoes retarded the wheels with a given force applied to them; and that at 60 miles and upward the brake force to be thoroughly efficient would have to be at least double that now usually employed in daily practice at speeds below 50 miles. With trains of considerable length it was shown that with the brakes in the most perfect order possible, trains could be brought to stand from a speed of 60 miles an hour within about 1,200ft., the brakes in these cases acting upon about 95 per cent. of the weight borne by the wheels of the train.

With a *perfect brake*, acting upon all of the wheels of an express train running at 90 miles an hour, it will be seen from Table No. 1 that at the end of 10 seconds the train would still be moving at a little over 60 miles an hour, and would have travelled a distance of about 1,130ft. As a matter of fact, with the brake force now fitted to trains, the reduction of the speed of trains running above 60 miles an hour would, under favourable conditions, not exceed two miles for each second.

Table No. 2 will show the distance run during each second after the application of the brake, *under the best actual conditions*, and at the end of 16 seconds the train would be running 61 miles an hour, and would have travelled in that time 1,796ft.

It requires no more than to call attention to the fact that the human vision is limited to show the increased risk that is incurred running trains at 90 miles an hour, as compared with trains running at 60 miles an hour and under. A system of signals to provide for these high speeds would have to be absolutely perfect, and arranged at such distances apart that they would necessarily limit the capacity of the road for all trains that are run at a much lower speed, unless a double set of signals were provided, one for high speed and one for low speed.

The danger to a person crossing the tracks at a level with trains running at these high speeds would be multiplied many times, unless a system of gates were provided, with danger signals at nearly a mile from each crossing, which could only be lowered when the gates at the crossing had been properly closed; in fact, everything would have to be arranged so that nothing would be left entirely to the judgment of man.

It was the explanation of these points in a converation, concerning the running of running of trains at high speed by electricity, with a writer of a daily paper, who was interested in the subject, which probably formed the basis of the article to which my attention has been called. It may, therefore, not be out of place in this letter to state a few facts which will bear with force upon the question of substituting an electric locomotive for the present steam locomotive.

Electricity on Standard Railroads.—The modern passenger locomotive, for high speed trains, must be capable of developing at least 1,200 h.p., and it costs about 10,000dol.; that is, the engine, boiler, feed pumps, steam piping, and everything necessary to produce motion cost about 8dol. per horse-power. For the operation of a train by electricity, in place of one steam locomotive, there would be required the following principal items, costing, according to present prices of electrical apparatus, approximately the figures set opposite:

A stationary steam boiler, 1,600 h.p.	$16,000
A stationary engine, 1,600 h.p.	1[illegible]
An electric generator, 1,600 h.p.	2[illegible]
Motor for locomotive, 1,400 h.p.	32,000
	$81,000

In addition to the above there would have to be added the proportionate cost of the buildings and outside electrical construction for the transmission of the electricity from the generator to the locomotive.

There are innumerable places where electrical power will profitably supplant the steam engine, but I feel confident that the above figures, or any modification that may reasonably be expected, will be a most serious obstacle to the utilisation of electricity for moving standard railroad trains, even provided all of the mechanical details necessary for the transfer of electrical energy of 1,200 h.p. from a stationary to a moving object shall be satisfactorily worked out.

TABLE No. 1.

Speed	90	miles per hour
Feet per second	132	
Time lost applying brakes	1	second, with full application at end of second second
Reduction first second	0	miles.
" second second	1½	miles.
" each second after	3½	miles.

With the above condition, the following figures are almost accurate (fractions omitted):

Seconds.	Feet travelled.	Speed at end of
1st	132	90
2nd	131	[illegible]
3rd	126	[illegible]
4th	121 +	[illegible]
5th	116 +	[illegible]
6th	111 +	[illegible]
7th	106 +	[illegible]
8th	101 +	[illegible]
9th	96 +	[illegible]
10th	90 +	[illegible]

Total run 1,130ft. in 10 seconds

To obtain the above results upon dry rails and upon the level would require a brake force of at least three times the total weight of the train, and this should be properly distributed upon every wheel in the train, and there would be needed a device on each car to automatically reduce the brakeshoe pressure as the speed decreased.

TABLE No. 2.

Speed	90	miles per hour.
Feet per second	132	
Time lost applying brakes	1	second, with full application at end of second second
Reduction first second	0	miles.
" second second	1	miles.
" each second after	2	miles.

The best to be expected from present well-fitted trains, with brakes in perfect order, in speeds above 60 miles per hour.

Seconds.	Feet travelled.	Speed at end of
1st	132	90
2nd	131	89
3rd	129	87
4th	126	85
5th	123	83
6th	120	81
7th	117	79
8th	114	77
9th	111	[illegible]
10th	108	73
11th	105	71
12th	102	69
13th	99	67
14th	96	[illegible]
15th	93	63
16th	90	61

Total run 1,796ft. in 16 seconds.

—*Railroad Gazette*

PORTSMOUTH.

THE NEW ELECTRIC LIGHT STATION.

On Thursday last week the Mayor (Alderman T. Scott-Foster, J.P.) laid the foundation-stone of the new central lighting station, for the building of which Mr. T. W. Quick has the contract for £8,400. The contract was accepted on October 4, and the following day Mr. Quick commenced work on the foundations. The first thing to be done was to clear the site of the burnt *débris* which had laid there since the destruction of the music hall on Christmas Day, 1890. In getting out the foundations some difficulty was experienced, as the ground was honeycombed with cellars and excavations, but these were partly filled in, and eventually a level trench 10ft. deep was constructed. This to a depth of 7ft. was filled with a solid mass of Portland cement concrete, 4ft. wide, and then 3ft. of brickwork brought the foundations level with the surface of the ground. Upon this solid base the walls of the buildings will be raised, these extending from Gunwharf-road to St. Mary-street.

The station is in three sections. Adjoining the Board school in Gunwharf-road is the boiler- house, intended to receive five Lancashire boilers, the room measuring 56ft. by 50ft. The remainder of the frontage on this side is devoted to the coal-store, 31ft. by 56ft., above which rise the offices. A passage across the centre of the site is to be utilised for economisers in connection with the boilers, and behind them the engine-room will be constructed, a large apartment 100ft. long by 60ft. wide, with frontage into St. Mary-street. Between this and the engine-house the chimney shaft will rise to a height of 120ft., being of octagonal tapering form, with brickwork varying from 3ft. to 9in. in thickness. It is proposed to have a great concrete cube, measuring 20ft. each way, as a foundation, but it may possibly be found necessary to make the block deeper and even to adopt other methods to obtain perfect security should the excavations reach the bed of shifting sand forming the subsoil. The whole of the buildings will be of red brick, plain but not unhandsome, the plainness of the material being relieved by terra-cotta panels and mouldings. The offices, forming a storey over the coal-store, will cause that building to rise to a height of 50ft., the engine-house will measure but 2ft. less from the ground line to the apex of the roof, and the highest point of the engine-house will be 30ft. As an instance of the solidity of the building, it may be stated that the steps and staircases throughout will be of granite. The Corporation, we may add, have secured sufficient ground in Gunwharf-road to double the boiler accommodation, and the engine house is to be of such dimensions that the machinery can be duplicated without extending the building. Mr. Quick's contract is to be completed in six months, and it is being carried out with Mr. E. Price as clerk of works. The engineers associated with Prof. Garnett are Messrs. Waller and Manville, from whose plans the buildings are being erected.

The foundation-stone, which occupies a place in the wall facing Gunwharf-road, is a block of red granite, bearing the inscription: "This stone was laid by his Worship the Mayor of Portsmouth, Alderman T. Scott-Foster, J.P., October 27th, 1892." In a cavity below the stone were placed current coins of the realm, copies of local newspapers, and an illuminated document containing the following record: "This stone was laid by the Mayor of Portsmouth, Alderman T. Scott-Foster, J.P., in the presence of the following members of the Electric Lighting Committee: Alderman G. Ellis, chairman; Councillor R. W. Beale, vice-chairman; Aldermen J. Moody and A. Cudlipp, and Councillors G. Ashdowne, W. Avens, G. H. Dean, H. Kimber, H. Fuller, H. Croucher, R. Barnes, J. McAskie, W. T. Dittman, A. L. Emanuel, J. H. Corke, A. Ross, and W. L. Bamber; engineers, W. Garnett, J. E. Waller, and E. Manville; T. W. Quick, contractor; Alexander Hellard, town clerk; Philip Murch, borough engineer. October 27th, 1892."

ALDERMAN ELLIS said it was his privilege as chairman of the committee to ask the Mayor to lay the memorial-stone of the first electric lighting station built in the borough. His Worship, in his inaugural address at his election on the 9th of November last, expressed the belief that the electric light in the borough would become an accomplished fact during his term of office. Many delays had occurred, but they were not caused by the committee or by the engineers, but were entirely due to the inertia of the Local Government Board, and had it not been for the persuasive powers of Mr. Beale, their vice-chairman, probably the present Mayor would not have been able to perform that ceremony. The portion of land on which the buildings were to be erected comprised 1,850 superficial yards, and was quite adequate for all present purposes, but as electric lighting had spread most rapidly in other towns they hoped it would do so in Portsmouth, and they had obtained land on the other side should it be necessary to extend the buildings. He then proceeded to describe the building, remarking that the chimney-shaft would be a great feature in the work. It would be 120ft. high, panelled, and with cast-iron ornamental capping at the top. A second shaft of similar character would probably be built at some future time. Each of the five boilers would be 30ft. long and 7ft. 6in. in diameter, and to reduce the cost of labour—always an important item in electric lighting works—they proposed to have mechanical stokers and lifters, so that one man would have full command, and could coal all five boilers, which would give an indicated horse-power of 1,400. There would be two separate pipes from the boiler-house to the engine-room, so that in case of accident to either boiler there would be no possibility of a breakdown. In the engine-room two distinct types of engines would be provided, the object being to see what kind was best fitted to do the work, for they had to economise, as coal was exceedingly dear in this part of England. The first two engines would be a horizontal compound-condensing engine, with slow-speed alternators with rope driving gear; and Parsons turbo-generator, which made 5,000 revolutions per minute. The indicated horse-power was something over 1,000. The reason that that site was chosen was that they would require a large amount of water for condensing in these engines, and a salt-water pipe 1,000ft. in length and 14in. in diameter would be laid, the waste water being discharged into the Camber. Special care would be taken in fitting the switch-room, and in the test-room would be instruments of the best description, not only for testing the meters, but for seeing that every main in each street was in safe and proper condition every day. He believed that when the scheme was carried out Portsmouth would be the best lighted town in the kingdom, barring London. The street lamp-posts would carry 124 arc lights, each giving 2,000 c.p., and on each column there would be two brackets, each bearing an incandescent lamp, which would be lighted when the large lamps were extinguished at 12 o'clock. In asking the Mayor to lay the stone, he remarked that no man in Portsmouth could have done more than he had to bring this scheme to a successful issue.

A silver trowel, suitably inscribed, having been presented to his Worship by the contractor, the Mayor laid the stone, and after declaring it to be well and truly laid, said that in erecting that building they were rearing another monument of the progressive policy which the Portsmouth Corporation had been carrying on for the last 25 years. They had done what but few corporations had yet done—taken the initiative in the matter of electric lighting—and he saw no reason why they should not make it a success. He further ventured to prophesy that when the inhabitants saw the light the demand for it would be such that they would have to increase the supply. A dinner in commemoration of the ceremony was afterwards held in the Town Hall.

Ilford.—At the meeting of the Ilford Local Board, Mr. Jameson, president of the Ilford Ratepayers' Association, forwarded a resolution passed by that body inviting the Board to take steps to introduce the electric light into Ilford, and asking that the Board would receive a deputation upon the subject. The Chairman said he did not think they could very well refuse to receive a deputation, but what might come of it was a different matter. The Board would not take upon themselves to make private individuals a handsome present out of the ratepayers' money, and he believed the idea emanated from a servant of the company which supplied Chelmsford. It was agreed that the deputation be received at the next meeting of the Board.

THE

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THE STUFFY UNDERGROUND.

Unless the present writer is greatly mistaken, there is a hackneyed quotation from the classics to the effect, when translated, that "man is at once the cleverest and most stupid of animals." If classic authors never originated such a thought, they have been greatly over-rated; for most folks discover the truth of the assertion as soon as they cut their eye-teeth. Those who had money subscribed it of yore for the purpose of making large holes through the ground, so that quick transit might be obtained from one part to another without impeding surface life. So far, so good: these men were clever, but they proved very stupid, and as dense as the smoke and fumes in the aforesaid holes, when they did not—and their descendants do not—insist upon keeping the air within these holes, at any rate, as fresh as the air outside in the world above. Possibly the reason why greater care, for instance, has not been taken to ensure good ventilation upon the Metropolitan and District Railways may be that the directors of these lines consider the air so indifferent (and in November so thick) that the passengers down below are just as well without it. Those who prefer sulphur and steam to sulphur and air will not appreciate this joke; they will consider such a reason to be eminently practical, and will continue to enjoy the pleasures of the "steam sewer" as they now exist. But, fortunately, these good folks are in a big minority; most passengers are only too anxious to see improved methods brought into use, and it is for their benefit that the following details are given, in order to show what has been done elsewhere to remedy bad ventilation.

Taking up, therefore, the question of underground steam railways, the subject of perfectly ventilating these becomes one of cost entirely. The engineering difficulties—in spite of such formidable phrases as "churning the air," "increased tractive energy required," etc.—are not more than any well-trained expert would overcome at once. The question turns solely upon the willingness of directors—that is, the shareholders—to make a certain expenditure in order to improve the line, and therefore influence the traffic. On the London underground lines there seems a complete unwillingness to incur any amount whatever of expenditure in order to better ventilate the tunnels and so render transit more endurable to passengers. Baltimore—or rather the Pennsylvania railroad—has other views, and it is just now engaged in erecting a very complete installation for ventilating by means of electric energy the Baltimore and Potomac tunnel. The conditions existing upon this length of line are apparently just such as obtain, say, between Gower-street and Portland-road in the Metropolis, but the results in the two cases will be found to diverge somewhat widely. The Baltimore tunnel is built for two tracks, is semi-circular in shape, of a radius equal to 13ft. 6in., and giving a space of 22ft. from rail level to top of arch. Its length is 3,600ft. between portals, or just over two-thirds of a mile. About half-way a large and ornamental square ventilating stack has been built

to a height of 100ft. from the ground level, resembling in style and formation a Venetian campanile. From the base of this shaft is driven a short connecting tunnel about 20ft. long, in order to draw out the foul gases from the railway tunnel. At the base of the stack is fitted a circular horizontal fan, 15ft. 6in. diameter, which is driven by a half-twist belt from a countershaft. A 45-h.p. Thomson-Houston electric motor actuates the countershaft by means of belting, and the power to drive the motor is obtained from plant near the mouth of the tunnel, specially put down for the purpose. From the details given more or less officially with respect to this installation, it appears that the capacity of the fan—at a peripheral speed of 658ft. per minute—is sufficient to change the air of the whole tunnel in five minutes, supposing the velocity of the air to be about 42ft. per second, a quite reasonable amount. The energy required to actuate the fan may be calculated out from this as equivalent to some 20 h.p. There is apparently, therefore, a good margin for losses by friction, train resistance, etc.

Now here is the case of a steam railway tunnel of considerable length running under city streets, and accordingly well patronised by passengers. The directors of the line evidently think well enough of this traffic to consider its wishes, and, if possible, carry them out. Not only do they instal special plant for ventilating the tunnel in perhaps the best way possible, but in order to avoid the nuisance of having a steam engine and boiler in the centre of the city for the purpose of actuating the ventilation apparatus, they go so far as to erect the prime motor outside the more populous districts, and make use of the most flexible and economical power conveyor that they can find in the shape of electric energy for working the fan. The London steam undergrounds do not need altogether to go quite so far as this. The electric current is at their door—right along the line, and nothing would be easier than to build an underground chamber, with connection to the railway tunnel, for each of the worst lengths of these lines. An ornamental chimney shaft and a ventilating fan, worked by an electric motor supplied with current from the street mains, represent the sum total of what else is required. Most people possessed of common sense to a reasonable degree will say that, if these means were adopted to secure better ventilation upon the underground railways, they would feel inclined to sell their omnibus shares. Meanwhile they don't.

There seems no immediate prospect, unfortunately, of electric traction being employed upon these lines to replace the use of steam locomotives, otherwise the bottom would be knocked out of the arguments in this article, and its destination the waste-paper basket. Assuming it, however, to be saved from such a fate, and rewritten only, then it might be proved that even on electric undergrounds the need for efficient ventilation still exists. The great advantage would be that energy for working the fans could be obtained from the electric mains by which the traffic is operated. This is not (but ought to be) done on the City and South London Electric Railway; but that's another story.

PHYSICAL SOCIETY, GLASGOW.

The tendency of the times is seen by examining the programmes of the various societies and institutions connected with physical science. Of late years the old and present students in the physical department at Glasgow have formed themselves into a society, which keeps them in touch with one another and with the various developments that progression in matters scientific causes in the scientific world. We have from time to time given papers read and discussed before this society, and this year purpose to do so more systematically. Indeed, as all the members of the society know, an arrangement was long since come to by which this paper becomes the recognised organ of the society. Hence, there is no breach of confidence in giving some idea of the work of the forthcoming session. The presidential address will be delivered this evening by the president, Mr. James H. Gray, M.A., B.Sc., the subject being the "Electromagnetic Theory of Light." The author has performed a much-needed service in putting briefly and lucidly in this address the theory of Maxwell, and the various investigations that have since Maxwell's time been carried out, and are corroborative of that great man's views. Reference is made to the work of Poynting, in his now famous papers on "The Transfer of Energy in the Magnetic Field," and "The Connection between Current and Electric and Magnetic Inductions in the Surrounding Field"; also to the investigations of Lord Kelvin, Helmholtz, Hertz, Lodge, Prof. J. J. Thomson, Profs. Ayrton and Perry, and others, all of which tend to show the close connection between the propagation of light and of electricity. But the full text of the address will appear in our next issue. Meanwhile, of the other ten papers to be discussed during the session six of them are electrical, as will be seen from the programme given elsewhere.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BARE COPPER MAINS.

SIR,—A good deal has recently been written on the heavy leakages and other troubles due to electrolysis which have taken place in the underground mains system employed by several of the Paris companies. This has been attributed to the extensive use of bare copper conductors supported on insulators. We take this opportunity of pointing out that such troubles have not occurred in England, although the use of bare copper conductors has been very extensively adopted in London and in other towns. As we were the pioneers in the matter, we wish to explain the points wherein our successful English practice differs so very completely from the unsatisfactory practice that has been adopted in Paris.

Seven years ago, when we were responsible for the design as well as for the contract for the works of the Kensington and Knightsbridge Company, we proposed to the directors the use of bare copper conductors, and accepted all the heavy risk and money responsibilities which such a novel system of underground conductors would have entailed if it had turned out to be a failure. Now that its success has been proved, we consider we are entitled to whatever credit and saving has attended the system.

In working out our system of bare copper underground mains, we at an early date saw the absolute necessity of so

arranging the insulating supports that everyone of them could be instantly accessible for the purpose of being cleaned or replaced. We therefore devised means of putting our conductors under considerable strain so that the number of insulating supports could be reduced to about 120 per mile—that is, about 14 yards apart, instead of being spaced about two yards apart, as is necessary if the bare conductors are supported on mere notches in earthenware or other insulating bridges. Those who have examined our system in the West end of London, and elsewhere, will have noticed at intervals of about 14 yards the covers of the openings at which access can be given to every insulator. We use separate cylindrical insulators of the lipped or telegraph form, one for each conductor, which gives great insulating surface, and prevents the accumulation of moisture, and as a result we can guarantee a degree of insulation that is quite impossible when a large number of mere notched insulators are used, even when the latter are quite new. Our system, commenced seven years ago, has yielded unexpectedly satisfactory results. The means that we have adopted to prevent the access of water and gas have been perfectly successful, the insulation resistance of the whole system has been far higher than has ever been the case where continuously insulated cables were used, for reasons which will be readily understood by those practically acquainted with the maintenance of an underground network connected direct to the houses. All practical engineers in charge of such systems know that 90 per cent. of such leakage as exists on a supply company's system occurs either at the junction of the house service lines to the company's mains, or on the service lines themselves, just within the consumer's premises. As in our bare copper system, these junctions are made in the street boxes, and can be instantly examined or detached for testing purposes. It is found in practice that the localisation of leakages is greatly simplified, and hence the leakage itself greatly reduced.

If we are right in insisting that the culverts should be made impermeable to water and gas, and that the insulators should be arranged so as to give great insulating surface, and be completely accessible for cleansing and repairing purposes, it will be seen that the troubles in Paris can be readily accounted for. The Paris engineers came over to see our system during its early stages and copied it in some respects, but in others fell into the very errors that we had already avoided. They still continue to use a great number of insulators placed close together, these insulators being of a poor insulating quality, and the great majority of them being completely inaccessible. They take no pains to make their culverts impermeable to water and gas, and no arrangements have been made to enable them to inspect or clean their system. We think that the unsatisfactory results in Paris should be a warning to some English engineers who appear to think that the good results we have obtained can be equally well obtained by the use of mere notched insulators placed close together, but we very much fear that the great reduction of surface and difficulty in keeping these surfaces clean will cause a repetition of the Paris troubles. The fact, however, has now been proved beyond doubt that a well designed bare copper underground system is superior to any existing system yet tried for a low pressure distribution network. Such a system costs less for maintenance, testing, cleaning, and coupling up to than any other system with which we are acquainted.—Yours, etc., Crompton and Co., Limited,

R. E. Crompton, Managing Director.

Mansion House buildings, London, E.C.,
November 1st, 1892.

GAS-ENGINE ECONOMY.

Sir,—Doubtless, many on reading Mr Guy's excellent article on gas engines must have been struck with the great variation of efficiency between engines of large and small power. Of course, had it been a case of working a large engine at a small power, one could fully understand the loss of efficiency exemplified by the extreme figures given under Tabulation 10, but I fear Mr. Guy must have experimented on some very ancient form of 3 h.p. engine, or used some very poor gas to require 37 cubic feet per brake horse power. A reference to the gas engine trials made by Prof. Kennedy, at the instance of the Society of Arts, show that in a 6 h.p. (nominal) Atkinson engine the consumption per brake horse power at full load worked out 22·60 feet, including gas for ignition jet, and we find a Crossley 9 h.p. (nominal) working at 24·1 cubic feet per brake horse power. Any of your readers will, on application to the host of gas-engine manufacturers, be furnished with tests of their various machines, showing in all cases a much more limited and more economical range of consumption than that laid down by Mr. Guy.

I would also find fault with the amount put down for "depreciation," considering the allowance for repairs (3 per cent.). I do not think any user of a decent gas engine would find a necessity for providing 7½ per cent. for depreciation, in modern engines a new cylinder lining and an occasional setting up of the piston will keep your engine in first class condition for, in one case to my knowledge, 20 years (i.e., 10 years working night and day). Now let us see what we get with my figures.

SMALL GAS ENGINE.

					Per B.H.P.
A.—Invariable cost.					
Interest on outlay at 4 per cent.	£0	14	3	=	[illegible]
Depreciation on outlay at 5 per cent. ..	0	17	10	=	[illegible]
Repairs on outlay at 3 per cent.	0	10	8	=	[illegible]
Attendance..............................	1	13	4	=	[illegible]
	3	16	1		[illegible]
B.—Variable cost.					
24 cubic feet (might be 23) for 3,000 hours, gas being 2s. 9d.	9	18	0	=	79
Oil, waste, and sundries........	1	5	0	=	10
	11	3	0	=	89

Per B.H.P. B.H.P. per hour
So total annual cost = £14 19 1 = 1·113

Whilst making these remarks I would express my appreciation of the clearness and thoroughness of the [illegible] the articles, which are highly interesting.—Yours, etc.,

[illegible]

REVIEWS.

Electricity: Its Theory, Sources, and Applications. By J. T. Sprague. Third edition, thoroughly revised and extended. E. and F. N. Spon, London.

We remember the first edition of this book coming into our hands for review—not to review for a weekly electrical paper, because there was not one in existence. The world jogged on and the writer became connected with the first of the modern electrical papers, and the second edition of Mr. Sprague's book came into his hands for review. The third edition comes whilst connected with this paper, hence our opinion has been delivered before two constituencies, and now before a third. It is well within our recollection, without turning to the review, that in our first effort we were almost as fully in accord with Mr. Sprague as now. He has progressed in some directions, while in others he has remained more or less stationary. It will be unnecessary then at any great length to discuss Mr. Sprague's views, his work having been for many years before the public. When first published it inaugurated a new departure—it smote the scholastic opinions hip and thigh; indeed, although the latter have gradually accepted many of the opinions originally propounded or developed by Mr. Sprague, they have not accepted all, as a recent controversy with Prof. S. Thompson will prove. In this controversy, however, there was a lack of finality, both parties holding to the view that their opponent was beaten out of court. Mr. Sprague has always been a thinker, not a follower. He differs from modern physicists upon a fundamental point, and this means he differs with them entirely. Modern physicists explain all phenomena connected with light and electricity by means of an hypothesis involving the "ether." Mr. Sprague objects to this, and refuses to bow down to the Baal that requires an admission of all and sundry proper-

ties to an unknown "ether" in order to explain certain phenomena by its aid.

"A wise humility," he says, "will recognise its ignorance and a wise patience await fuller knowledge, rather than invent an artificial knowledge, which can only serve to disguise people's real ignorance from themselves, and to make them contented with it."

There is no humility among modern electricians: they formulate laws which are no laws, formulæ which require constants, and altogether a knowledge asserting, without admitting of contradiction, that what is is right—that is, so long as one of their sacred number does not suggest something different, when all follow the bell-wether. We fear that, although many of the heresies which appeared in the first edition have become orthodox, there still remain enough to keep Mr. Sprague outside the sacred circle and among the heretics. In fact, this one on the "ether" is enough, or we might refer to his preference to the old chemical notation rather than the new as a point of difference.

One or two more general references. We wonder somewhat that Mr. Sprague spared space to refer to the one and two fluid theories. For all practical purposes they are as dead as the proverbial doornail. Our wonder may not be so great when he tilts at those who, like ourselves, see more advantage in fostering the idea of the magnetic circuit and its phenomena by symbolism similar to that which serves for Ohm's law; yet it is evident that he does not here feel quite sure of his position. An elaborate paper, recently published in America by C. P. Steinmetz, is claimed to have solved any and every difficulty anyone may have had in accepting the law of the magnetic circuit. Perhaps Mr. Sprague will become more wholly converted to our views as time goes on. He knows that long before the term "magnetic circuit" was accepted as it is now, we strenuously upheld its reality. Ohm unmistakably gave us his law, and as unmistakably must the credit of insisting upon Ohm's law as applicable to the inductive circuit be given to F. C. Webb. Had Webb's book appeared 10 or 15 years later than it did, it would have been universally applauded. As it was, it served for waste paper, and the man's name is never heard except when some of his old friends insist upon his recognition. If proof were wanted as to the utility of adapting Ohm's formula to the magnetic circuit, it is forthcoming from the fact that every practical man connected with dynamo design uses it.

But were this paper as bulky as a quarterly review, it would not give sufficient room to touch upon all the controversial points which scintillate through these pages. It must suffice then if we give—as is the object of such notices as these—a fair idea of the contents of the book. The contents are divided into 15 chapters, and may be said to be in two divisions; the first eight chapters dealing more especially with theory, then follow six chapters on various applications, the fifteenth being on definitions and explanations of terms, concluding with a good index. It is in the first few chapters that Mr. Sprague's idiosyncrasies crop up largely, the practical part, however, being intensely practical, and in electrolytic work, for example, containing a large amount of information not to be found elsewhere. The first chapters deal with the different forms of electrical phenomena and measurement. Our references to this part will take all the space we can spare, and on the point we cannot go with Mr. Sprague. No doubt, logically, he might compel our adhesion, but expediently, no. We refer to his desire to expunge the term "resistance" and put in its place "capacity." He says, "Resistance is the arithmetical reciprocal of the conductance of the circuit—*i.e.*, of its capacity to permit the action we call current. Resistance becomes intelligible when thus considered, although it is an altogether different thing from what the term means in mechanics; the conception will be clear if we consider a conductor not as a whole, but in its components, as if built up of a number of unit conductors, all alike, side by side, and each passing equal current—that is, each having *unit capacity*, and offering *unit* resistance in the true sense of friction." This is all very well and very true, but it helps nobody to a better understanding of electric phenomena, and there is such a great desire nowadays for everyone to tinker at nomenclature, that unless it is to be revised once for all for a quarter or a half century, authors should be chary of introducing new terms. We will say nothing of conductance, voltance, and the terms first suggested, we believe, by Mr. O. Heaviside, for the simple reason that they are in a kind of half-and-half way already adopted.

In all these chapters there is a vast amount of information given, and given in a manner at once exhaustive and convincing that cannot be obtained elsewhere. The student of "mind" by carefully examining Mr. Sprague's original articles, and the various editions of his book, would have a capital study of "mental activity." In every case there is an obvious effort to delve to the bottom of things so far as a knowledge of older and more modern researches enables one to go. What is said is said after experimental test, and only adopted when so tested. We commend Mr. Sprague's theories, and his abundantly practical information, to every electrical student. The book is one which, whether we agree with its conclusions or not, ought to be carefully read and studied by every man who professes a desire to know something about electrical matters.

ELECTRIC LIGHTING OF SMITHFIELD MARKETS.

The function which the Lady Mayoress will perform to-day will be an exceedingly interesting ceremony. That event will be the formal inauguration of the electric light installation at the East, West, Poultry, and General Markets, known as the Central Markets, Smithfield. It will be remembered that some time ago Messrs. Julius Sax and Co. proposed to the Corporation of London to erect plant for the supply of electric light to the shopkeepers in these markets at a rate equivalent to that paid by them for gas illumination, and also to erect general lamps for lighting the avenues free of charge. That suggestion was accepted by the Corporation of London, and the company in question were commissioned to carry out the work, which is to-day partially completed. The temporary plant has been erected on a large space of vacant ground which Messrs. Sax and Co. have acquired immediately on the northern side of Charterhouse-street. This plant is arranged at a depth of no less than 40ft. below the street level, at the side of the arch or arches running over to the other side of the markets. It comprises a Davey-Paxman locomotive type boiler, and an engine of 50 h.p. by the same makers, driving an Elwell-Parker continuous-current dynamo, giving 200 amperes at an E.M.F. of 100 volts. From an improvised switchboard the current passes, by means of mains carried under one of the arches, straight to four distributing-boards erected in the markets. These boards, one of which is arranged in each market, distribute the current to some of the lamps in the various shops and avenues, and will eventually distribute it to all the lamps. Before proceeding further with this brief description, it may be as well to mention that, on the same site as that of the temporary plant, a permanent generating station will shortly be erected. This station, which will be built at the side of the Metropolitan Railway, which passes it, will have a separate set of rails leading up to it, so that the coal trucks for the supply of the furnace may be run direct into the generating station yard. This station, similarly to the temporary one, will be arranged 40ft. below the street level. This arrangement allows of the mains being laid conveniently along the arch into the markets, and thus avoids tunnelling. The station will contain six Davey-Paxman locomotive type boilers, six triple-expansion engines of 200 h.p. by the same makers, and six Elwell-Parker direct-current dynamos, each of 200 units.

The latter will be coupled direct to the engines, the E.M.F. being, as in the case of the temporary plant, 100 volts. This plant will supply no less than 8,000 incandescent lamps, ranging in power from 16 c.p. to 50 c.p., and this number has already been wired. To-day, 500 incandescent lamps of these varying powers will be started, 100 of which are of 50 c.p., and which are supplied by the company to the Corporation of London for the illumination of the avenues. Of these, 25 lamps are arranged in each market. As already stated, a switchboard has been erected in each market, at a

height of about 25ft from the ground, so as to be out of the reach of meddlesome persons. Two distinct circuits lead from each board. The 100 Corporation lamps, or rather the 25 in each market, are switched on and off by means of a novel arrangement. This consists in connecting the switch to a lever attached to two chains, which have rings at their lower ends. When it is desired to switch these lamps on or off, an employé, with a long pole having a hook at its upper end, simply pulls down either chain, thus extinguishing or putting on the current. The lamps in the shops are switched on or off from the same boards by means of keys, which are used by the employés, who reach the switchboards by means of ladders. The 100 lamps belonging to the Corporation are, as already mentioned, of 50 c.p., and these will be lighted to-day. They are suspended over the avenues in the four markets by means of wrought-iron piping carried on the cross beams, the leads passing through the piping, to which they are conveyed in ordinary wooden casing; the leads for the shops are similarly run. The lamps in the latter are partly arranged under the ceilings of the shops and partly outside, the leads from the casing being run to the lamps in wrought-iron piping. These lamps are throughout arranged in clusters of three, forming a lantern, which the company call "fairybeads." These lanterns have corrugated glass reflectors, gilded to throw yellow rays of light on the meat, whilst the avenue lamps have silver reflectors. This wrought-iron piping is, we may mention, completely insulated from the horizontal girders, from which much of it is suspended by means of ebonite washers and bushes. It is not intended to use any arc lamps, and the incandescent system is carried out on the simple parallel system, which, we are informed, is arranged so as to be capable of being converted at any time into the three-wire system.

The contract which Messrs. Sax and Co. have with the Corporation is for 21 years, the 100 50 c.p. lamps are supplied free of cost, and the current will be paid for by consumers at a rate equivalent to that which they paid for the same amount of gas light last year, but, if desired, payment can be made by meter.

THE ELECTRIC LIGHTING OF DANGER BUILDINGS.*

BY CHARLES FREWEN JENKIN, B.A., A.M.I.C.E.

The danger from ordinary electric lighting, carried out in accordance with such rules as those drawn up by the Phœnix Fire Office, will soon be able to be estimated from the statistics of the fire offices. It is probably very small, but is certainly not non-existent; and it must be remembered that for every fire of sufficient magnitude to come under the notice of a fire office, there must be many trifling cases of fire, overheating and sparking, any one of which would be sufficient, in a dusty powder building, to cause a disastrous explosion.

These considerations show the necessity for taking much greater precautions in danger buildings than in others. At the same time, the danger arising from electric light varies immensely in different classes of buildings, all of which may come under the definition of "danger buildings" as given in the Explosives Act. Probably the most dangerous buildings are those used for some of the processes of gunpowder manufacture, such as granulating and pressing.

This paper contains a description of the system of electric lighting, devised by the author, adopted in some of the danger buildings of this class, at the Royal Gunpowder Factory, Waltham Abbey. At that factory, as is often the case, the powder buildings are spread over a considerable tract of low-lying ground, covered with trees, and intersected with numerous water-channels. The trees are valuable as screens in the cases of explosion, and the water furnishes both motive power and safe means of transport. The buildings are light brick and wooden structures, partly surrounded, as a rule, by heavy traverses, designed to prevent an explosion from being communicated to the other buildings in their neighbourhood. Inside is the machinery. In "dusty buildings," when the machinery is at work, the whole house is filled with a cloud of powder dust, which settles over everything, and issuing from the doors and windows, covers the outside of the buildings and ground in the vicinity with a thin layer of explosive dust. In "non-dusty buildings" there is comparatively little dust, though there is in most machine houses enough to cover the interior with a considerable sprinkling, but not enough to cause any appreciable quantity to settle outside the buildings. In both classes of buildings there is always a considerable quantity of powder undergoing the process of manufacture. The layer of powder dust is sufficient to transmit ignition from any point within the limits of the "dusty area" where it may originate to the bulk of the powder in the building. The powder dust, then, is the chief cause of the danger, since the least spark, or other cause of fire, occurring within the "dusty area" will cause an explosion of the whole of the powder in the building. The distinction between dusty and non-dusty houses has been long recognised, but having regard to the precautions necessary to make electric light safe, the author slightly rearranged the classification according to the following definitions.

Dusty houses are those in which the operation carried on produce such an amount of dust that the outside of the buildings and the ground in the neighbourhood may become covered with a layer of dust sufficient to communicate any fire occurring within the dusty region to the interior of the building. The following buildings at the Royal Gunpowder Factory are classed as dusty houses: dusting houses, granulating-houses, breaking-down houses, press houses.

The neighbourhood of a dusty house—namely, the whole area over which explosive dust may collect in sufficient quantity to be dangerous—has been called the "danger area." (See Home Office "Memorandum on Electric Lighting of Factories and Magazines for Explosives," December 31, 1891.) The boundary of this area is necessarily indefinite. It depends on the rate at which dust escapes from the building, the nature of the ground, the climate, and particularly on the length of the longest spell of dry weather which may be expected. At Waltham, the author having consulted with the men of longest experience in the [illegible] fixed the boundary of the danger area at 50 yards from the nearest part of the building.

Non-dusty houses are those where there is never a sufficient amount of dust to cover the exterior of the building or the ground in the neighbourhood. The [illegible] buildings at the Royal Gunpowder Factory are classed as non-dusty houses: incorporating mills, moulding [illegible] stoves, magazines.

I. Dusty Houses.

If it were possible to keep all the electrical apparatus outside the "danger area," it would render the [illegible] perfectly safe. But it is clearly impracticable to light the interior of the building by lamps 50 yards from the nearest part of it. It is, however, possible to keep much of the apparatus outside this area, and to protect that part [illegible] it in such a manner as to render it extremely safe.

The appliances which must be inside the "danger area" are, obviously, the lamp and the leads to it. Nothing [illegible] should be allowed inside the "danger area." And further, it is not necessary to take even the lamps inside the building, for sufficient light can quite well be obtained from lights outside the windows. Before describing the precautions which must be taken to make electric light safe, a brief list of the possible sources of danger is given.

Sparks at any point within the "danger area" arise from (1) a broken wire; (2) connection between positive and negative leads; (3) the blowing of a fuse; (4) the action of a lightning protector; (5) the opening of a switch; (6) the breakage of a lamp; (7) lightning flash.

Heat.—(1) of the lamp itself; (2) at the lampholder [illegible] at any defective joint; (4) in the leads; (5) owing to leakage or partial connection between positive and negative leads; (6) owing to leakage to earth.

In order to avoid these dangers, the following precautions should be taken.

Sparks.—(1) The wires must be protected from breakage. If there are trees near, the wires must be taken underground, or they will be liable to be broken by [illegible]

* *From selected papers of the Institution of Civil Engineers.*

branches; (2) the leads must be kept apart and well insulated, or else enclosed in a dust-proof case; (3, 4, 5) fuses, lightning protectors, and switches must not be admitted inside the danger area; (6) the lamp must be protected; (7) lightning protectors must be placed close outside the danger area, to prevent lightning from being carried to the building by the wires.

Heat.—(1) The lamp must be enclosed in an outer globe, of sufficient size to keep cool; (2) suitable lampholders must be used, and they should be protected, like the lamp, from dust; (3) joints in the wires should, if possible, be avoided; (4) the leads must be thoroughly protected by fuses; (5, 6) first-class insulation, suitable for the special conditions, should be used; great care being taken in selecting the method of support for the wires.

With these conditions in view, the author arranged the following system: The main leads, which are carried overhead, terminate at a post, situated at least 50 yards from the building to be lighted, on which is fixed the switch-box, which contains all the fuses, switches, and lightning protectors used in connection with the building. The leads from this box, consisting of a pair of insulated wires to every lamp, are carried underground through iron pipes to the lamps. The lamps, which are all outside the buildings, are supported in front of the windows on lampposts of various forms, designed to suit the special circumstances of each case. The principle aimed at in the design of these is to provide a support for the lamp entirely independent of the building. In all cases the wires are carried up to the lamp enclosed in an iron pipe, on the end of which the lamp is fixed. The pipe used is wrought-iron steam-pipe, with ordinary socket joints, coated inside and out by Angus Smith's process. It starts at the switch-box, to which it is fastened by a flange, and runs underground to the building, where it branches, as required, to the various lamps. The size of the pipe is determined by the number of wires which it has to carry. The following table shows the sizes which have been found most suitable for different numbers of lamps, each lamp having two wires:

		Inches.
Lamps 1.	Inside diameter of pipe	1
" 2.	" " "	1¼
" 3, 4.	" " "	1½
" 5, 6.	" " "	1¾
" 7, 8.	" " "	2
" 9, 10.	" " "	2¼

Cast-iron "drawing-in boxes" are placed at all the angles of the larger pipes, and the same box is used wherever the branches leave the main pipe, except that a smaller box is sufficient at the junction of the branches leading to single lamps. Drawing-in boxes are not necessary at all the bends of the smallest branches; but where they are not used running joints are provided on both sides of the bends. The insertion of these boxes at the bends and branching points greatly facilitates the drawing-in of the wires. No tees or elbows are allowed, on account of the sharp edges which are left inside these fittings. The sharp edges left on the insides of the pipes when they are cut are carefully removed before the pipes are fixed in their places. Those ends of the pipes which are screwed into the drawing-in boxes are belled out slightly so as not to catch the wires as they are drawn in. The joints are all made with red lead, including those round the lids of the drawing-in boxes.

The leads to the lamps are single No. 16 copper wires, insulated with vulcanised indiarubber and lead-covered, supplied by the India Rubber, Gutta Percha, and Telegraph Works Company, with a guaranteed insulation of 300 megohm miles. No joints are allowed in the leads; but as the wire is made in long lengths, this causes very little waste. The wires are drawn into the pipes, after they are completed, by means soft spun-yarn ropes. The boxes, though small, give ample room to bend in the bight of the wires without kinks.

The switch-box is shown in Fig. 1. It is made of teak, of watertight construction, with either a wooden or a slate back on which the switches, etc., are fixed, and a sliding wooden front. The positive and negative leads enter the box through two Johnson and Phillips's fluid insulator "leading-in pipes," on opposite sides, and are joined to the two main fuses. The fuses are in turn connected through two lightning protectors to the two main switches. From the switches the leads divide, and are joined to the two rows of single lamp fuses. The lead-covered wires are connected to the other terminals of these fuses, and pass straight down into the iron pipe, the end of which is fixed to the bottom of the box. A wooden ring is fitted round the top end of the iron pipe to preserve the wires from being cut while they are being bent into position. The earth-plates of the lightning protector are connected to the iron pipe.

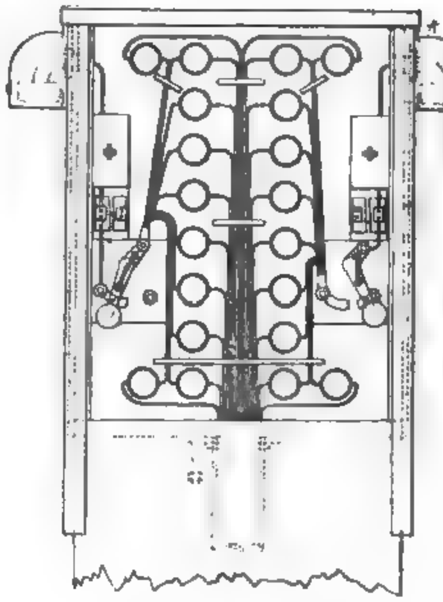


Fig. 1.

The lamp, Fig. 2, is a modification of that invented by Colonel Watkin in 1885. It consists of a cylindrical cast-iron piece, *a*, tapped to screw on to the end of the iron pipe carrying the leads and fitted with a nipple, on to which the lampholder is screwed. The outside of the piece *a* is screwed, and fits into the cast-iron piece, *b*, which forms a cover to the glass globe, *c*, to which it is attached by the copper straps, *d*. The joint between the glass and iron cover

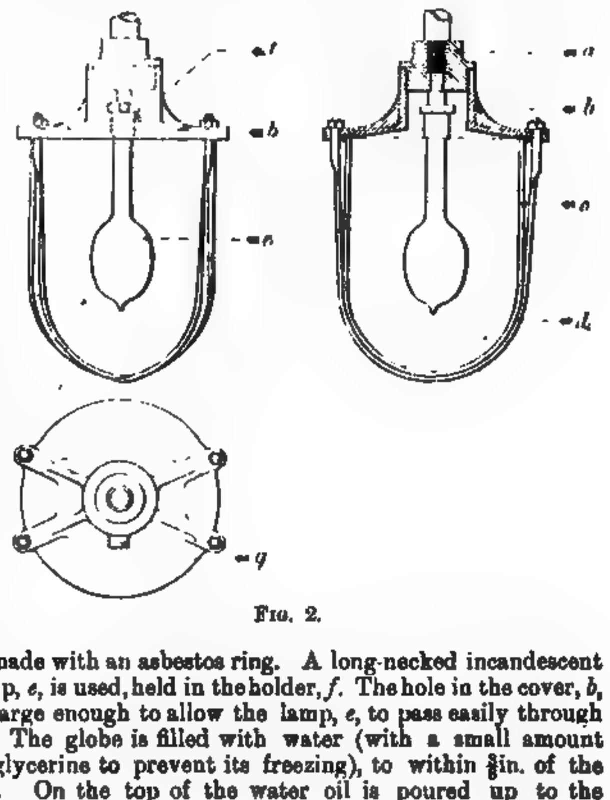


Fig. 2.

is made with an asbestos ring. A long-necked incandescent lamp, *e*, is used, held in the holder, *f*. The hole in the cover, *b*, is large enough to allow the lamp, *e*, to pass easily through it. The globe is filled with water (with a small amount of glycerine to prevent its freezing), to within $\frac{3}{8}$in. of the top. On the top of the water oil is poured up to the level of the filling-hole, *g*, which is afterwards closed with a screw. A part of one side of the globe is silvered on the outside, and the rest of that half painted with white enamel.

The details of the methods of attaching the lampholder, and leading in the wires, are shown in Fig. 3. The cast-

iron piece, *a*, is recessed slightly near the bottom; and the nipple, which is tinned, is run in with sulphur, *s*. Fitting loosely inside the nipple, and projecting above it, is the earthenware insulator, *t*, which has two small holes formed in it, through which the bare wires, *w* (the insulation having been removed) are threaded. It rests at the bottom, on the insulator, in the lampholder. Two small holes, *v*, are drilled in the sides of the lampholder, level with the top of the lamp, to allow the oil to enter and circulate. The incandescent lamp is kept cool, and dust is prevented from settling on it by the water. The oil greatly reduces evaporation, and prevents the condensation of water on the lamp cap and interior of the holder. This point is of great importance, since, if the plaster of Paris in the lamp cap gets wet, heat is rapidly generated, and the metal contacts corrode by electro-chemical action. The oil also serves as an insulator and cooling agent round the lampholder, and prevents dust from settling there. It likewise seals the asbestos joint. The object of the sulphur is to insulate the lampholder. The earthenware insulator is to preserve the insulation on the wires from the decaying action of the oil. The expansion of the water and oil with any air they may contain, and also the expansion of the air enclosed in the top of the lamp, cause the oil to rise slightly when the lamp is hot. This takes place without the oil coming in contact with the rubber insulation. The shape of the insulator is designed to prevent the creeping up of oil by capillary action.

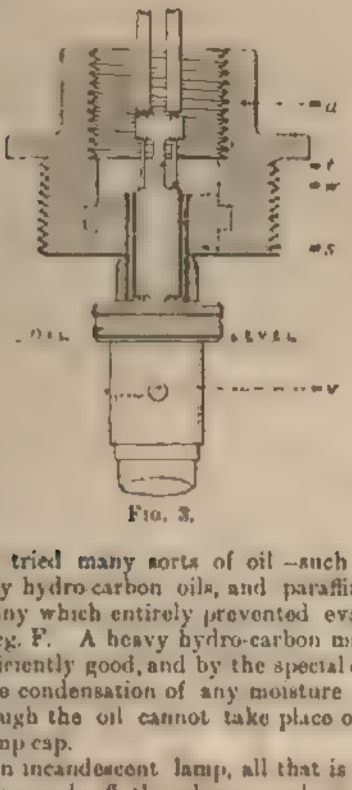


Fig. 3.

The author tried many sorts of oil—such as rosin oil, rape oil, heavy hydro-carbon oils, and paraffin wax—but failed to find any which entirely prevented evaporation of water at 140deg. F. A heavy hydro-carbon machinery oil was found sufficiently good, and by the special construction of the lamp the condensation of any moisture which does evaporate through the oil cannot take place on the wires, contacts, or lamp cap.

To replace an incandescent lamp, all that is necessary is to unscrew the cap, *b*, off the plug, *a*, and carefully lower the globe, full of water and oil. The lamp can then be changed and the globe replaced. The joint round the top of the globe is never broken, and there is no risk of spilling oil and water.

The author made a few experiments to find out what size of globe was necessary in order that no part of it should get too hot when the lamp it contained was run continuously. The maximum allowable temperature recommended by H.M. Inspector of Explosives in the "Memorandum on Electric Lighting of Factories and Magazines for Explosives," is 140deg. F. Four globes of different sizes were tested; the results were as follows:

Globe A, containing 8oz. of water, boiled in two hours.

Globe B, containing 130oz., attained a maximum temperature of 156deg. F.

Globe C, 200oz., attained a maximum temperature of 132deg. F.

Globe D, 192oz., attained a maximum temperature of 131deg. F.

The incandescent lamp in each case was absorbing 60 watts. The temperatures given are those of the surface layer of water in the globe; the temperature of the surrounding air being 60deg. F. Globe D is that adopted in the lamp above described.

A safety switching-off device is applied as follows. A weight is attached to the two main switches by a wire over a pulley, so as to open the circuit. A pull wire is run from the switches to some convenient point within reach of the building, by means of which the switches can be pulled in, raising the weight. In the event of any defect appearing in the lighting, the release of this wire will at once entirely disconnect the leads. If this wire, in course of time, breaks, the defect will show itself at once.

The author believes that these arrangements fulfil all the conditions laid down. The following points may be specially noticed: The wires are entirely enclosed in dust-tight iron pipes the whole way from the switch box to the lamps—that is, for the whole distance traversed within the danger area. The iron pipe will not only keep out the dust, but tend, in case of any short circuit, to develop it rapidly, and so to blow the fuse. There are no joints in any of the wires. The wires, being lead covered, are well protected against wet and iron rust. The drawing in of the wires is easily and quickly accomplished. The fuses are set to blow at four amperes, which is well within the safe carrying capacity of the wires, and far above the regular working current. Thus there is perfect protection, and the fuses are quite cold in ordinary work. The main fuses are only intended to act if lightning short circuits the dynamo. They are also very large for the normal current. The lamp globe, already described, affords complete protection from the danger of the lamp itself.

II. Non Dusty Houses.

In non-dusty houses, many of the sources of danger before enumerated do not exist.

Sparks.—There is no danger from sparks if they are kept clear of the building.

Heat.—There is no danger from heat if it is kept out of the building. The following precautions are then sufficient:

Sparks.—The wires need only be protected from breakage or short circuiting in the immediate vicinity of the house. The fuses, etc., need only be kept a few feet off the building. The lamp, which is necessarily very near the house, should be protected from breakage. A lightning protector should be fixed on the main leads at a little distance from the building.

Heat.—The same precautions, as in the case of dusty houses, are necessary, but only in the immediate vicinity of the building.

The following description gives the particulars of the method of lighting non-dusty houses: The main leads which are carried overhead terminate, as before, at a post situated at any convenient point near the building, to which is fixed the switch box, containing, in this case only, the two main switches, main fuses, and lightning protectors. The leads (insulated) from this box are carried overhead again on posts round the building, at about 6ft. from the outside wall. The same lamps are used, fixed, as before, on posts outside the building, in front of the windows. The connection between the leads and lamps is made as follows: One of the supporting posts for the overhead leads is fixed opposite every lamp; each of these posts carries a cast-iron fuse-box, containing two single lamp fuses. From this box a 1in. iron pipe runs overhead to the lamp, a distance of about 6ft. Branch wires are attached to the overhead leads, and carried into the fuse box, and connected to the fuses. From the fuses, two wires are carried in the iron pipe to the lamp. By this arrangement the leads are kept sufficiently far from the house to be safe, in case of their breaking; while the branches to the lamps, which necessarily approach the house more nearly, are completely enclosed, and also protected from mechanical injury. There is a fuse on every lamp, as before.

In conclusion, a few words may be said about some other classes of danger buildings. At Waltham Abbey there are, besides the powder factory, a gun-cotton factory, and a cordite factory. In the gun-cotton factory, since there is no dust and hardly any gun-cotton in a sensitive state,

no special precautions need be taken beyond those necessary in an ordinary house or factory, except that the acid fumes should be specially guarded against. Such lampholders as Messrs. Woodhouse and Rawson's chemical holder may be used. In the cordite factory, as there is no dust, the lamps may be taken inside the houses, but should be protected by suitable globes. Also the leads should be entirely enclosed. The fuses, etc., should be outside the buildings. A modification of the first system described may be used, carrying the pipes inside the buildings. The dry gun-cotton buildings should be treated like dusty gunpowder-houses.

TRADE NOTES AND NOVELTIES.

ELECTRIC TRANSFORMERS.

This invention of Messrs. Pyke and Harris's relates to high-tension transformers and other electrical power converters, with liquid insulation, in which a more or less viscous nature,

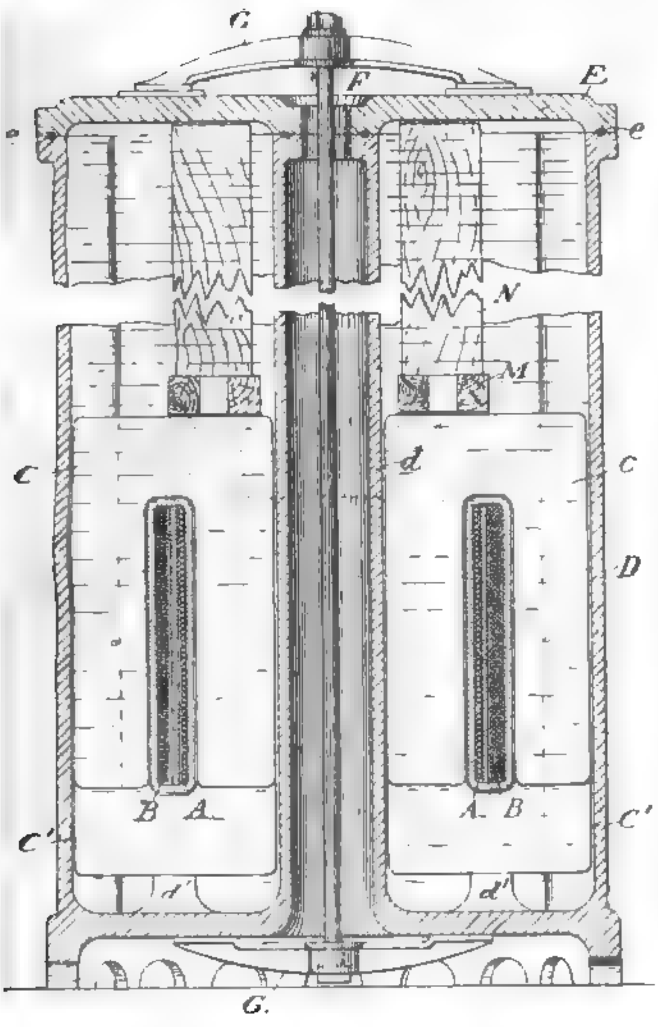


FIG. 1.

such as heavy petroleum free from all volatile distillates, is employed. The apparatus is constructed with all, or as much as possible, of the mechanical insulation of a permeable character. The transformer is placed in a container of earthenware, corrugated or provided with external ribs, serving at the same time as a cooling vessel, the height of which is about three times that of the transformer proper. The transformer consists of concentric coils of wire arranged so as to form a ring, which is arranged in sections, separated from each other by porous insulating material, which can be easily penetrated by the insulating liquid. The coils are held together by the iron of the transformer, which is arranged in saddle-pieces, placed vertically and radially, so that each set of plates enters one of the corrugations of the vessel. Each horseshoe plate encloses on each side a radial section of the coil. Each set of saddle-pieces is applied to the coil alternately from the top and from the bottom, and secured by corner bolts. The transformer has stood a very severe test, and by nature of its disposition it can be taken apart, new primary and secondary coils inserted, and the whole put together again in a very short time. Fig. 1 is a vertical section, and Fig. 2 half horizontal and half plan of the Pyke and Harris transformer. A is the primary; B, the secondary coil; C and C_1, the iron of the transformer; D, the earthenware pot serving as a cooling vessel, provided with an axial tube, *d*, reaching up to the top of the vessel; E is the lid, and *e* indiarubber packing rings placed in circular grooves between the vessel and the lid; G G are

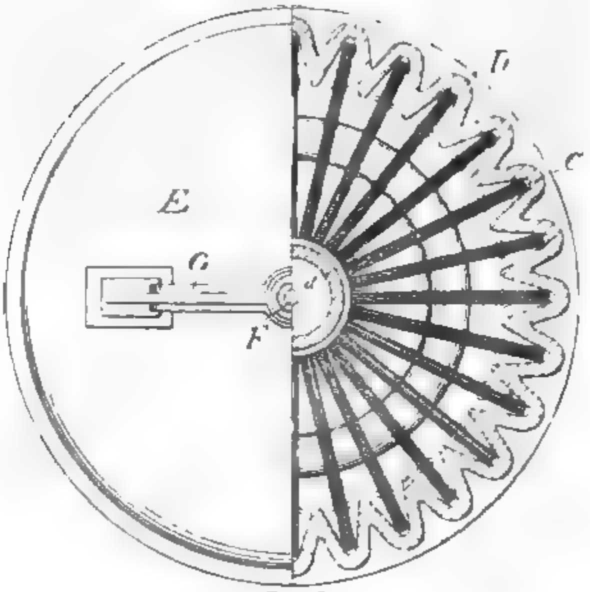


FIG 2.

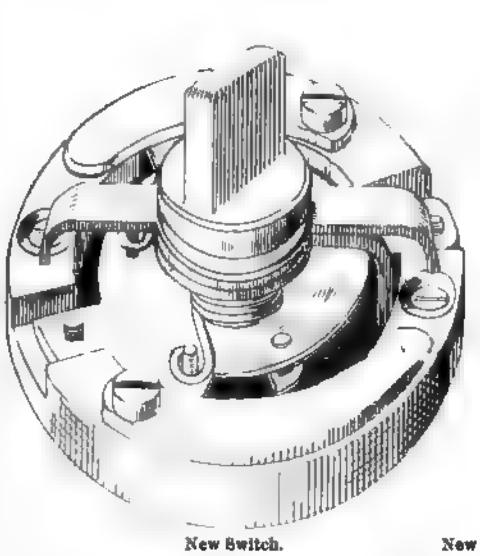
washers connecting the bolts with the vessel and lid; M is an insulating ring placed in the top of the transformer.

NEW BROCKIE-PELL LAMP.

We herewith illustrate a small globe lamp specially designed for use in shop windows and other indoor positions where little space is available. It is of the well-known Brockie-Pell type, manufactured by Messrs. Johnson and Phillips, and gives a steady light, with either continuous or alternating currents of five to 10 amperes when in parallel with 50 volts or upwards, or two in series with 100 volts and upwards, or any number in series. The first fifty of these lamps are in use at Messrs. Jones Brothers' new premises at Holloway, and we are informed are very successful.

A NEW SWITCH.

This is an automatic locking and unlocking quick-break switch, which in our opinion is superior to any which has yet been



New Switch.

New Brockie-Pell Lamp

produced. In an ordinary switch, fitted (as this is) with a spiral spring, which prevents contact being made between the break and the pole-pieces when the switch is off, the methods whereby the pull of the spring is overcome when the switch is turned on is merely the friction between the break-piece and the pole-pieces, and is, therefore, liable to break the current by slipping unless completely locked. It is also liable to arc in consequence of partial contact, but in order to obviate

these objections this switch is made. To the break piece is fitted an arm at right angles, which protrudes through the base of the switch. On the bottom of the base is attached a sliding bolt, which engages the arm when the switch is turned on and prevents the break piece from breaking contact with the poles. In order to keep the sliding bolt in position to engage the arm, a small spring is fitted in such a manner that when the arm passes the bolt the spring shoots the bolt forward; this constitutes the automatic locking arrangement. In an ordinary switch, as mentioned, the break piece is usually fastened securely to the spindle, which holds the switch handle, but in this switch the break piece is free to turn. Immediately under the break piece is fixed a circular cam to the spindle with a slot cut upon its edge of about one third of its circumference. This slot engages a pin in the break piece, so that when the handle is turned to make contact, the cam engages the pin, and causes the brake piece to turn with it, until the arm of the break piece has passed the bolt previously described. At the bottom of the spindle underneath the base is fitted another cam or small projection which engages the bolt, both these cams are fastened to the spindle. It will therefore be observed that when the break-piece is engaged by the bolt by means of its arm it cannot return to its original position without being released, and no vibration or violent jerking can remove it; albeit, the spindle is free to be turned back, and in so doing the bolt is withdrawn by means of the projection at the base of the spindle and the arm is released, and immediately this occurs the break piece flies off the pole pieces by the action of the spring connected with it. The switch is according to Richardson's patent, and is being put on the market by Messrs. Hurk and Edwards.

LEGAL INTELLIGENCE.

HOPKINSON v. ST. JAMES'S AND PALL-MALL ELECTRIC LIGHT COMPANY, LIMITED.

Alleged Infringement of Patent.

This was an action in the High Court of Justice, before Mr. Justice Romer, in which Dr. John Hopkinson, the well-known electrician and mathematician, applied for an injunction and incidental relief in respect of an alleged infringement of letters patent 3,576 of 1882 granted to the plaintiff for improvements in distributing electricity and in apparatus to be employed for that purpose.

Sir Richard Webster, Q.C., Mr. Aston, Q.C., Mr. Moulton, Q.C., and Mr. Hopkinson, Q.C., are for the plaintiff; and Sir Horace Davey, Q.C., Mr. Finlay, Q.C., and Mr. Roger W. Wallace, for the defendants.

Sir Richard Webster, in opening the plaintiff's case, said his client was a Senior Wrangler, a position which his Lordship would appreciate, and well known in the scientific and legal world. This, of course, did not entitle him to any privileges as a litigant, but it had some bearing on a case involving questions of patent law, with which Dr. Hopkinson was intimately acquainted. The rights under the patent in question had been disposed of by Dr. Hopkinson for a large sum, but he was still legal owner of the patent, as a trustee and was the proper person to sue for its infringement. Two inventions were covered by the patent. One only had been infringed, but both parts of the patent were attacked by the defendants, and it was open to them to say that a part of the patent claimed too much, though it was not suggested by the plaintiff that they had infringed that portion of it. The part alleged to have been infringed was that which covered an invention of great importance in electric lighting known as "the three wire system," which was used only in connection with incandescent lamps. There must in every system be a source of electricity, conductors, and lamps. This invention only related to the conductors. One of the commercial difficulties in the way of successful electric lighting was the great expense of large copper conductors, and in this respect the present inventor had effected a great saving. The three-wire system was invented almost simultaneously by Dr. Hopkinson and in America by Mr. Edison, and was applicable to the ordinary modes of generating electricity, whether by means of dynamos or secondary batteries. The pressure of the electricity was measured by volts, and there was a sort of analogy in hydrostatics, the volts being about synonymous with the pressure of the water. The quantity of electricity was measured by amperes, which might be said to be equivalent to the volume of water. The lamps used were on the multiple parallel bridge system, and the conductors, as a rule, were made of copper. A copper lead went from one pole of the dynamo and came back to the other pole. In multiple lighting there was no continuous commercial current unless the lamps were connected by bridging. Disregarding the terms plus and minus and positive and negative currents, the learned counsel said he should speak of the currents as the flow and return currents. Under the ordinary system there was an up and down bridging, as some of the lamps were off and on respectively. By putting on greater pressure Dr. Hopkinson was able to dispense with a large amount of copper in the conductors—in other words with a higher voltage he could do with less copper. When the lamps were "in series" the whole current passed through all the lamps; when they were in parallel there was a subdivision of the current. But under this old system there was not equal potentiality in the lamps. The pressure was required to be constant. Dr. Hopkinson's main invention consisted in connecting a third (middle) wire and coupling two dynamos in series, so that the middle wire only took back the balance of the current not required for lighting the lamps placed in parallel. The learned counsel then illustrated the changes in effect with the assistance of a model with miniature incandescent lamps, which he said was worked by an illustrious operator (Lord Kelvin). Under the new system the electric intensity could be doubled by adding only slightly to the amount of copper. When the lamps were turned off the balance of the current came back by the middle wire, and the illumination of the lamps left on remained unaltered. The learned counsel then went more elaborately into the details of the first invention with the aid of the specification, and said that if this part of the patent was good there was no question about infringement. There was no substance in the alleged anticipations. The second part of the patent, which was also attacked by the defendants, though it was not alleged that they had infringed it, was for the invention of a galvanometer for ascertaining in the engine room the potential at the far end of the conductor. The learned counsel then described this invention in detail, and concluded an address of some hours by saying that he attempted, without going into the matter scientifically, to explain generally what would be more particularly explained by the scientific witnesses, and that he protested against the opening speech of counsel being quoted to witnesses as if it were intended to describe the invention with absolute scientific accuracy.

Mr. Justice Romer asked how long the case was likely to last.

Sir Richard Webster said he hoped it would be finished in three days.

Sir Horace Davey said three hours ought to be enough to get rid of it, but

Mr. Justice Romer said he was not sanguine of disposing of a patent case in so short a time as three hours.

It was stated in court that no fewer than four Senior Wranglers were engaged in the case—viz., Mr. Justice Romer, Lord Kelvin, Mr. Moulton, Q.C., and the plaintiff.—*Times.*

COMPANIES' MEETINGS.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY, LIMITED.

The thirty-eighth ordinary general meeting of this Company was held on Wednesday at Winchester House, E.C., Sir John Pender, M.P., presiding. The Marquis of Tweeddale, on entering the room a little late, was warmly received, it having become known that his lordship was travelling in the Scotch express on the [illegible] especially to attend the meeting of the Company, of which he is a director.

The **Chairman**, in moving the adoption of the report, said that the gross receipts for the half year ended June [illegible] £216,988, showing a decrease compared with those of the corresponding period of 1891 of £17,[illegible], of which over [illegible] to loss on exchange, and the balance to the reduced rates [illegible] tralia. It was, however, proposed at the request of the [illegible] shortly to raise the tariffs to Australia by 6d. a word [illegible] diminish the loss arising from the guarantee arrangement [illegible] amounted to over £[illegible],000 during the first year of the experimental tariff. Personally, the Directors would have preferred [illegible] the 4s. tariff a little longer, in order that it might have been fairly tested, but as the colonies were all suffering from severe commercial depression, and had intimated that [illegible] the tariffs were increased they might have to cancel the [illegible] at the end of the second year, the Directors had had no [illegible] but to acquiesce in their views. This was the first time in [illegible] recollection that Governments had asked for the rates to be put up. The companies had generally been pressed all round to [illegible] them. He might say that when the rate was fixed at [illegible] advised the colonies very strongly to make it [illegible], the reduction being from 10s. The Company had now agreed to the [illegible] 4s. 9d., and he hoped that the traffic would be as large as [illegible] at 4s. If so, the loss would be so insignificant that he hoped [illegible] would in future go on satisfactorily, the benefit being very [illegible] in favour of the telegraphing public. The working expenses [illegible] the half year had been £79,281, showing an increase of £[illegible] over those of the corresponding period of 1891, but as the [illegible] expenses had been £9,041 more than for the same period of last year, those expenses over which the Directors had control really showed a decrease of £4,[illegible]. The usual interim dividends at the rate of 5 per cent. per annum had been distributed for the past half year, amounting to £[illegible], and the satisfactory balance of £70,271 was carried forward. [illegible] picked up cable a triplicate line had been laid between Penang and Singapore, costing £25,[illegible]. The Foochow-Shanghai section had also been strengthened during the half year by the [illegible] renewal and alteration of the line at the mouth of the Yangtse-Kiang river, where interruptions from ships' anchors were becoming frequent. The cost of this operation had been £[illegible], and with the cost of the triplicate Penang-Singapore it had been charged to the general reserve fund, which now stood at £[illegible], after they had expended £1,102,[illegible] out of revenue on cable renewals, duplications, etc., since the formation of the Company. This showed that, without increasing their capital, they had practically doubled the operating power of their system. They had really done more, because they had found out how to duplex their cables, which had given them an enormous cable power. The contract for laying a submarine cable between Acheen and the [illegible]

pany's system at Sumatra on account of the Netherlands-Indian Government had been successfully carried out, and the line had been opened for traffic. The cost of the work had, of course, been defrayed by the Government, and the line would, he hoped, eventually become a good feeder to the Company's system. They had the satisfaction to announce that the competition with which the New Zealand cables were at one time threatened by the Government of that colony had been averted, and an arrangement had been come to with the Government for reducing the charges over the New Zealand cables as follows: For inter-colonial messages, from 8s. 6d. to 2s. for 10 words; and for international messages, from 1s. to 3d. a word; the Government guaranteeing the Company against three-fourths of the risk of any loss which might arise from the reduction, the Company bearing one-fourth. The value of the traffic in question was £26,258, the Company's risk being £4,386 if no increase of traffic resulted. With an increase of 50 per cent., however—which would not be an excessive estimate for such substantial reductions—the Company's liability would be only £3,297. Their relations, therefore, with New Zealand were now thoroughly satisfactory, and he hoped that all the parties concerned would thus derive considerable benefit in the future. It had also been arranged for New Zealand to join in the Australian guarantee and receive the benefit of the cheap rates to Australia. The tariff between Europe and New Zealand would, therefore, be reduced from 10s. 2d. to 5s. 2d. per word for ordinary telegrams. The date for bringing the new tariffs into force had not yet been definitely settled, but it would probably be the 1st prox For the last 20 years the Company's relations with Queensland had not been satisfactory, and the Government of that colony had endeavoured in every possible way to oppose the Company. The sum which Queensland would have to pay to reduce its tariff to the same rate as that which prevailed in the other colonies would be only £1,000 a year. The principal reason for the hostility of the Queensland Government towards the Company was because the latter adopted another route instead of the Queensland system when telegraphic communication was first established with Australia 20 years ago. A short time since the merchants of London went in a deputation to the Queensland Minister of Telegraphs and urged upon him the desirability of his Government's joining with the other colonies in the guarantee referred to. So far, nothing had resulted from the deputation. He could only say that they had done everything possible to conciliate Queensland and to endeavour to induce the Government of the colony to take a different view. It was recently pointed out by a member of the Colonial Parliament that the inferior position which Queensland held in comparison with the other Australian colonies in this matter was prejudicial to her, and the Government were advised to put the colony on the same footing. The Prime Minister however, replied that the Government would not join in any agreement that would give any assistance to monopoly. The Government had made an agreement with another company for a cable to New Caledonia, and the Prime Minister said he thought that they would be defeating their own object by assisting this Company. He (the Chairman) believed that they had agreed to pay £2 000 a year towards the New Caledonia cable—a project from which he could not see that any benefit would result to the colony. If, on the other hand, the Queensland Government gave up the policy which they were pursuing towards the Company there was no doubt that they would very largely benefit the interests of the colony, and he had no doubt that the colonists would eventually insist upon this course being taken. In conclusion, the Chairman said he doubted whether he had been able on any former occasion to put a more satisfactory account of the position of the Company before them than he had done that day.

Mr. Francis A. Bevan seconded the motion, which was unanimously adopted.

MONTEVIDEO TELEPHONE COMPANY.

The annual general meeting of the Montevideo Telephone Company, Limited, was held on Monday at the offices, 96, Gresham House, Old Broad-street, E.C.

The **Chairman** (Mr. Herbert Ward), in moving the adoption of the report, said that during the year they had realised an increase of profit over the previous year equal to about 1¼ per cent. of their preference share capital. That profit was entirely due to economy in management. Mr. E. F. Powers had resigned the post of managing director, which resulted in a considerable saving. The London expenses had now been reduced to their lowest. The Board had earned a dividend, but they had expended the money in purchasing their central offices. The latest advice informed them that the lower portion of that property had been let for £254 per annum. Last April he visited Montevideo, and as the result of his investigations he was able to report most favourably upon the orderly management that prevailed, and also upon the general condition of the Company's property.

Mr. C. H. Sandford seconded the motion, which was adopted.

After a long discussion, the following resolution was agreed to, on the motion of Mr. Praed: "That a dividend at the rate of 3 per cent. per annum be declared upon the preference shares of the Company, such dividend to be not immediately payable, and that a committee be formed to agree with the Directors as to the best manner of carrying out or securing the payment thereof."

Eastern Telegraph Company.—The receipts for the month of October were £61,069, as against £60,784 for the corresponding period last year.

NEW COMPANIES REGISTERED.

United Electric Tramways, Limited.—Registered by Millington and Drew, 14, Great Winchester-street, E C., with a capital of £30,000 in 6,000 shares of £5 each Object: to acquire tramway undertakings in the United Kingdom or elsewhere, and to develop and work the same, either by horse, steam, electricity, or other power, and to carry on business as carriers of passengers, goods, minerals, and merchandise of every description; as omnibus proprietors, the business generally carried on by a railway company, etc.; to acquire concessions for the establishment of tramways, the installation of electric lighting or motor power, or other electrical installations, and all privileges connected therewith. There shall not be less than three nor more than seven directors; the first are to be elected by the signatories to the memorandum of association. Qualification: 50 shares. Remuneration: Chairman, £200; ordinary directors, £150 each; in addition, 10 per cent. of the net profits after payment of 8 per cent. dividend.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—The receipts for the week ended October 28 were £3,099.

Catalogue.—We have received a catalogue of patent dynamos from Messrs. W. H. Allen and Co., Lambeth.

Colchester.—The Colchester Council are making enquiries as to the cost of a provisional order for electric lighting.

Wolverhampton.—The tenders for Wolverhampton electric plant are required to be sent into the town clerk by Nov. 15.

Cuba Submarine Telegraph Company, Limited.—The receipts for the month of October were £34 more than for the corresponding period last year.

West India and Panama Telegraph Company.—The receipts for the half-month ended October 31 were £2,049, against £1,982, showing an increase of £67 as compared with the corresponding period last year.

New Swindon.—Mr. Morris is the member of the New Swindon Local Board who protests against the purchase of the gas works until full information is acquired as to the cost of an electric light installation, and his efforts ought to be aided by technical engineers.

Scarborough Telephones.—The Water Committee of the Scarborough Town Council have received an estimate for the establishment of telephonic communication between the pumping stations at a cost of £480, and an annual charge of £51. Further discussion of the project was postponed.

City and South London Railway Company.—The receipts for the week ending October 30 were £889 against £802 for the corresponding period of last year, or an increase of £87. The total receipts for 1892 show an increase of £1,299 over those for the corresponding period of 1891.

Staffordshire.—The Committee of the Staffordshire County Council reported at last meeting that the tender of the Electric Construction Corporation, Limited, Wolverhampton, for lighting the Werrington Industrial School by electricity had been accepted, and that good progress has been made with the work, the installation now being nearly completed.

Newport.—A sub-committee of the Newport (Mon.) Lighting Committee have been in London for the purpose of making enquiries with regard to the installation of the electric light adopted by the St. Pancras Vestry, which is regarded as the most successful installation by any municipal authority in England.

Bridgend.—A special meeting of the Bridgend Local Board was held in committee last week to consider the electric lighting question, and although the Committee was of one mind on the matter it was thought best to postpone a resolution to apply for a provisional order until the next ordinary meeting of the Board.

Chelmsford Fire Alarms.—At the Chelmsford Town Council last week it was agreed, on the recommendation of the Fire Brigade Committee, that electric bells be provided at the firemen's houses, with a central fire alarm at the Shire Hall, and that the lowest tender for carrying out the work, that of Mr. T. H. Dennis, of Chelmsford, at £41. 18s. 2d., be accepted.

Bowdon and Altrincham.—At meetings of the Local Boards interested, held on Monday evening, provisional agreements were come to with the Manchester Edison-Swan Company for the lighting of the whole district of Bowdon and Altrincham with the electric light. Powers will be taken both for streets and houses. A central station of large capacity will be put down.

Electric Schemes.—The *Western Morning News* has a long article on "Electricity as an Illuminant," noticing certain suggestive schemes in the North, more particularly in the little town of Nelson. This newspaper is very open to the advocation of progress in business, and its articles may perhaps serve as a challenge to draw forth further practical discussion of electric schemes for the West.

Pacific Cable.—The Queensland Government, Reuter says, has resolved not to join the other Australian colonies in the guarantee to the Eastern Extension Telegraph Company, by virtue of which the rates to Great Britain are greatly reduced. The reasons given by the Government for this decision are that the guarantee is calculated to interfere with the completion of the Pacific cable, and to assist a monopoly.

Crompton-Howell Accumulators.—A short time ago Mr. J. C. Howell, managing partner of the Llanelly Electric Lighting Company, secured an order from New York during his visit there to supply his patent accumulators to a New York central station, and several persons in the employ of the firm have left for New York, including Messrs. P. Powell, H. Cornish, F. Bell, T. Thomas, D. Davies, J. O'Brien, and H. Glascodine.

Russell and Co.—The firm of Russell and Co. has been formed to carry on the business of electrical engineers and contractors at 11, Queen Victoria-street, London, under the management of Lord Russell, lately of the firm of Swinburne and Co. They propose to list and supply every requisite that can be demanded for electrical work of every description, besides undertaking the contracting for supply and erection of any desired plant. The firm are about to issue a comprehensive illustrated catalogue of electrical plant and fittings.

City Lighting.—We hear that the Electrical Supplies and Fittings Company, Limited, are at the present time busily engaged in the City. Among the numerous installations that they have on hand at the moment are the Alliance Marine and General Insurance Company, Capel-court; the Royal Insurance Company, Lombard-street; Liverpool and London and Globe Insurance Company, Cornhill; Melchers, Runge and Co., Fenchurch-avenue; Ahrens and Co., Fenchurch-avenue; Farquharson, Roberts, and Phillips, Upper Thames-street; McEwan and Co., Lombard-street, etc.

Western and Brazilian Telegraph Company.—Including the amount brought forward from 1891 (£4,486. 18s. 2d.), the balance to the credit of the revenue account is £49,367. 18s. 3d., from which has to be deducted £12,489. 10s. for debenture interest and £6,610. 10s. for the debenture redemption fund, leaving £30,267. 18s. 3d., of which £14,000 has been placed to the reserve fund. This leaves £16,267. 18s. 3d. The Directors recommend the payment of a dividend of 3s. per share, free of income tax, on the ordinary shares for the half year, being at the rate of 2 per cent. per annum, carrying forward £1,062. 5s. 3d.

Heckmondwike.—The Electric Lighting Committee of the Heckmondwike Town Council reported at the last meeting that they had held an adjourned meeting on October 14, when a letter was read from the Co-operative Wholesale Society, Manchester, offering to take 600 lights at the rate of 6d. per Board of Trade unit. It was resolved to write to the different electric lighting companies asking upon what terms they are prepared to put down a plant at their own cost and supply the town with the electric light, giving the Board power to purchase the plant under an agreement at the end of a term of years. The minutes were approved.

Electric Launches.—We are pleased to learn that Messrs. Woodhouse and Rawson United, Limited, of the Strand Electric Launch Works, Chiswick, have just received an order from J. West, Esq., of The Albany, Piccadilly, for a handsomely finished electric launch, 35ft. in length, to be built in their best style, and to travel at a high rate of speed. The boat will be used entirely for pleasure purposes, and will add yet another to what is undoubtedly the best form of river locomotion. There is no doubt that the electric launch business is proving remunerative, and large number of enquiries are constantly being received by makers from all parts of the world.

Hull.—The Hull Corporation having applied to the Local Government Board for power to borrow £25,000 for laying down the first installation of electric light in Hull, Major-General Henry Darley Crozier, R.E., on 28th ult. attended the Hull Town Hall for the purpose of holding an enquiry into the matter. The proceedings were only formal, there being no opposition. The Mayor (Councillor Robson), Councillor Holder, chairman of the Electric Lighting Committee, the town clerk (Mr. R. Hill Dawe), and the borough electrical engineer (Mr. Lowis) were present. The details of the scheme were laid before the inspector, who afterwards visited the lighting station.

Lewes.—At the East Sussex County Council meeting this week, Major Edwardes will move that £200 be expended in electric light fittings for the County Hall. The following is the report of the sub-committee on electric lighting: "That, having had a consultation with the deputation of the Lewes Town Council and discussed the question of electric lighting, your sub-committee recommend that in the event of the Lewes Town Council establishing an electric lighting station or deciding to hand their powers over to a public company to be formed for that purpose, that the East Sussex County Council agree to take from them the electric current necessary to light the County Hall buildings, at a cost of 8d. per Board of Trade unit, and that the requisite fittings for the light be provided for the purpose, at a cost to be ascertained before finally deciding the question."

Leclanche Cells.—Messrs. Leclanché and Cie., of Paris, have appointed Mr. R. Aylmer, of 47, Victoria-street, Westminster, their sole concessionnaire for the manufacture and sale in Great Britain and the colonies of the well-known Leclanché and Leclanché-Barbier primary batteries. Mr. Aylmer informs us that as a guarantee the cells he supplies are genuine Leclanché batteries, Messrs. Leclanché and Cie. have accorded to him the exclusive right of using their trade mark. He sends us a catalogue of these cells, and special attention is directed to the new Leclanché-Barbier cylinder agglomerate batteries of both wet and dry type there described. These are M. Leclanché's latest patent, and are introduced into England for the first time. They have become well known abroad, and are there, it is stated, rapidly superseding all other forms of Leclanché batteries, as being by far the most efficient and economical cell yet produced.

Ammeters and Voltmeters.—It may be remembered that Messrs. Hodges and Todd were burnt out in their workshops some months ago. It did not take them long to start again, and what with the accuracy and cheapness of their instruments, added to the notice attracted to them, the firm have rapidly taken a good place in manufacturing for the trade. Business has increased, and now this enterprising young firm are, we are pleased to see, forced to move from 19, Kirby-street, Hatton-garden, to more commodious premises at 82, Turnmill-street, near Farringdon-street Station, and have largely increased their plant and machinery. The speciality of Messrs. Hodges and Todd are ammeters and voltmeters of both spring and gravity type, which they stock from 10 up to 500 amperes, and they also do a large business in manufacturing instruments, switches, and so forth for the trade. We wish them every success in their new premises.

Burnley.—The work on the Burnley central electric station has been commenced. The building will be of brick, relieved with terra cotta courses, and the boiler house will measure internally 54ft. by 48ft. It will contain two Lancashire boilers, 28ft. long and 7ft. in diameter, adapted for 120lb. working pressure, space being left for a third boiler. The boiler house will also contain fuel economisers and feed pumps. The generating room will be 60ft. by 48ft., and will contain eventually three engines of 125 i.h.p., driving three dynamos, and is to be provided with travelling cranes so as to facilitate any repairs or alterations to the machines. The station will also be fitted with a battery of accumulators from which the electricity will be supplied when the engines are not working. The distribution will be on the three-wire low-tension system, and the mains will be armoured and laid in the earth. Consumers will supply their own wires subject to Corporation regulations.

Crompton's Arc Works, Chelmsford.—The Chelmsford people are extremely proud of the electric works of Messrs. Crompton and Co., Limited, and when last week a huge new boiler was seen being drawn slowly through the streets to the works, public enthusiasm rose to a high pitch. It is an indication of the constant extension of the business of the Company. The boiler is a [illegible] steel Lancashire boiler by Penman and Co., of Glasgow. It measures [illegible] in diameter, and is of 240 h.p. It is fitted with [illegible] and water purifier, and will displace three temporary locomotive boilers. A new Willans and Robinson engine is also being [illegible]. The present machinery in the works supplies light for [illegible] 8 c.p. private lights, and the equivalent of 1,000 public lamps. The new engine is capable of supplying 3,500 8 c.p. lamps, and will therefore allow for 1,000 extension, when one of the existing engines will be also used. Space is allowed for the erection of a second large engine when the lighting requires this [illegible].

Lancaster.—The Lancaster Corporation are the owners of the borough gas works, and they have also powers under a provisional order to supply the town with the electric light. A sub-committee have been considering electric lighting projects, and have visited various installation stations in various parts of England. They have submitted a report, in which they recommend [illegible] of the low-tension system. The Brush Electrical Engineering Company, Limited, Messrs. Crompton and Co., Limited, and Messrs. Mather and Platt are to be invited to furnish the Corporation with a complete scheme and detailed specifications for the lighting of the borough, together with estimates of the cost at which they would be prepared to carry out such a scheme. The sub-committee's report was considered by the Town Council on Friday. Councillor Helme explained that the consumption of gas was advancing by leaps, and that unless the electric light was adopted a large expenditure would have to be incurred in connection with gas. The report was adopted.

Bath.—A report, which had been deferred from the last meeting, was presented in reference to electric meter testing, at the meeting of the Bath Urban Sanitary Authority last week. Its most important recommendation was that apparatus should be supplied to the inspector, Mr. J. W. Gatehouse, at an expense not exceeding £40, for the testing of private consumers' meters. At the Surveying Committee there was some opposition to this proposal. Mr. Sturges, who in moving its adoption, addressed himself to that point. The gas inspector, he said, was employed [illegible] apparatus be needed, and the expenditure proposed was sanctioned by the Local Government Board. Mr. Dyer said the [illegible] use of the gas inspector's apparatus came to the Authority, but as it was at present Mr. Gatehouse would keep all the fees. Mr. Moore said the gas inspector had a large salary, but Mr. Gatehouse was remunerated by fees. After further discussion, Mr. Sturges replied, pointing out that if they came to the conclusion that Mr. Gatehouse was overpaid by fees, they could alter the arrangement, as they had only a short time agreement with him. The report was adopted.

Leeds.—The Board of Trade have now given their formal approval of the system adopted by the Yorkshire House-to-House Electricity Company, Limited, for supplying energy under their provisional order. The system is described as a high-pressure alternating current transformer supply at constant pressure, to transformers fixed in suitable positions on consumers' premises, and the distributing mains consist of [illegible] and in cast-iron conduits under the footways where possible. The laying of these conduits is nearly completed so far as the area in the centre of the town, included in the company's [illegible], is concerned, about 5,000 yards having been laid. [illegible] applications for light are being received from owners and occupiers of premises in other thoroughfares, and this will necessitate extensions in the area of supply. The laying of mains along the route to Headingley will, it is expected, be commenced in the course of a few days. The company are meeting with an [illegible]

ingly good demand for the light, the applications already booked including almost all the leading banks, as well as public buildings, hotels, clubs, private residences, shops, warehouse, offices, etc. Strenuous efforts are being made to be ready for commencing the supply of current by the 1st of December next.

London Street Mains.—The Highways Committee of the London County Council at the last meeting reported that they had considered a notice, dated 14th October, 1892, from the Westminster Electric Supply Corporation, of intention to lay mains in South Bruton-mews, and a further notice, dated 28th October, of intention to lay mains in Ebury-street, Victoria-square, and Albert-street. The works proposed are unobjectionable, and they recommend that the sanction of the Council be given to the works referred to upon the condition that the street boxes shall be similar to those previously approved by the Council, and that the covers thereof shall consist of iron frames filled in with material to suit the paving. The Notting Hill Electric Lighting Company had given notices for mains in part of Notting Hill-square, and for mains in Observatory-gardens and avenue. The mains will be laid in three 2in. pipes, and the street boxes to be constructed will be of the pattern already approved in the previous notices of the Company. There is no objection to the proposed works, and the committee recommend that the sanction of the Council be given to the works referred to on due notice being given. They had also considered a notice from the Kensington and Knightsbridge Electric Lighting Company of proposed extension of mains in Hyde Park-gate, and agree also to these.

Peterborough.—The Peterborough Town Council have complained to the gas company "of the present and for some time past interior quality of the gas supplied by them." The company, in reply, say the gas is several candle-power above the parliamentary standard. The parliamentary standard is 14 candles, and the price is 3s. 4d. per 1,000 cubic feet. Well may the good people of Peterborough complain, in these days of electric lighting, at having to put up with 14-c.p. gas, especially at the price named. We notice also, from the local papers, that there is a well founded objection to the spoiling of the beautifully-painted ceilings in the cathedral by their exposure to the products of the hundreds of gas burners now used inside the building. The new organ, now being built for this cathedral at a cost of £4,000, will perhaps be the finest instrument in England, and electricity will be employed in its manipulation. This organ as well as the ceilings will suffer by exposure to the unconsumed carbon and other products of the great number of gas burners. We heartily wish, for the sake of this grand old monument, that those who are endeavouring to have the cathedral lighted by electricity may see their wishes carried out. We should think that Peterborough, with its compact business area, its good hotels and public buildings, and its 14-c.p. gas, would be a happy hunting ground for an electric lighting company, and the Town Council's complaint to the gas company would seem to show that any reasonable proposal, from a sound source, would be entertained by the powers that be.

Victoria-embankment and Bridges.—At the London County Council on Tuesday, the legality of the proposed electric lighting of the Victoria embankment and Westminster and Waterloo Bridges received attention. The Highways Committee reminded the Council that on 28th of June last the following resolution was passed: "That, subject to an estimate being submitted to the Council by the Finance Committee as required by the statute, it be referred to the Highways Committee to carry out, at a cost not exceeding £10,000, an electric installation with the necessary plant for the lighting of the carriageway, footways, and parapet wall of the Victoria-embankment, and that the Highways Committee do also confer with the Bridges Committee and the Parks Committee respectively, and report whether the plant can be established on a sufficient scale to enable Westminster and Waterloo Bridges and the Embankment gardens to be lighted from the same source." Upon the estimate being considered by the Finance Committee, doubt was expressed whether the Council could undertake the installation without first obtaining parliamentary powers for the purpose, and also whether the Council had power to erect works on the land under the Charing Cross railway bridge, upon which land it was proposed to place the generating works in connection with the electric light installation. The Highways Committee have, at the request of the Finance Committee, carefully considered these points, and have taken the opinion of counsel upon them; and the result is that they have come to the conclusion that, in order to prevent any risk of the action of the Council in this matter being called into question, it is advisable that the Council should obtain parliamentary powers to carry out the proposed installation. They accordingly recommended that it be referred to the Parliamentary Committee to take the necessary measures to obtain the sanction of Parliament in the next session, to the carrying out of the electric light installation on the Victoria-embankment and the Westminster and Waterloo Bridges. This was approved.

Belfast.—At the Belfast City Council meeting on Tuesday, Alderman Johnston proposed that the minutes of the meeting of October 13, so far as they referred to the question of electric lighting, be confirmed. Mr. Kelly seconded. Mr. Wellington Young said he had heard of what took place at the meeting yesterday. If he had been present at that meeting he would have voted against the proposal to accept £4,000 for the first seven years, and £5,000 for a second term of seven years. Mr. Masterson called Mr. Young to order. Mr. Young said he only made that statement in order to ask if there would be an opportunity of discussing the question. The Lord Mayor: Certainly. Mr. M'Cormick said he thought that the installation should be five times as large, and he would move that the minutes be amended by the insertion of 50,000 lights in place of 10,000 lights. Mr. R. Wilson seconded. Mr. Lindsay asked what powers had the Council of charging for the light, or of compelling its use. The city clerk said the Corporation had power to charge up to 8d. per unit. Mr. M'Cormick said he had advocated this installation three years ago. In Bradford an installation of 30,000 lights was put up, and there the demand was speedily more than the station could supply. What had taken place in Bradford he had no doubt would take place in Belfast, which was an equally progressive city. Dr. Steward supported. Mr. Andrews asked if there was anything in the provisional order that limited the extent of electric lighting. The city clerk said there was no limit. Mr. Masterton asked if there was any advantage in having a small installation; if it were cheaper to have a larger one than that proposed he would go for it. Alderman Bates pointed out that the installation proposed was an initial one. Mr. Ritchie spoke in favour of district stations. There was a loss of voltage by having a large central station equal to 5 per cent. every 100 yards. Alderman M'Connell asked what fund the money would come from. The city clerk said there was a balance of £70,000 on the gas account which could be utilised. Alderman M'Connell said he understood that it was not at present proposed to light the streets, the lighting proposed to be put up at once was for private purposes. After some remarks from Mr Robert Wilson and Mr. F Curley, Mr Wellington Young said most of them knew but little about electric lighting. What many of the public knew about electricity had been gained through the columns of a newspaper—he referred to the *Belfast Evening Telegraph*, which had given a great deal of attention to the question lately. The amendment was then put to the meeting, and lost by 20 votes to 11. Mr. Robert Wilson moved that the 10,000 light be increased to 25,000. Mr. Bennett seconded. The city clerk pointed out that it was not intended to start lighting the streets, because the cost would be three times that of gas. If the Gas Committee were instructed to light the streets with electricity they would carry out the directions. This further amendment was defeated by 21 votes to 7, and the motion of Alderman Johnston contemplating the establishment of plant for 10,000 lights was passed. The Council afterwards received a deputation from Cromac Ward to protest against the erection of further gas works, and to urge the establishment of electric light works.

Glasgow Tramways.—The conclusion arrived at by the writer in the *Glasgow Herald* who has been giving a series of articles on the tramway motor question is that horses should be abolished, cable should be used in the crowded streets, and electric traction in the quieter suburbs. The Tramway Trust seem to be intending to make a fair beginning, and have recently advertised for the equipment of certain quieter routes on the trolley system. They have been in communication with the Thomson-Houston system, and other firms will no doubt have a chance. Two routes are being proposed for experimental lines—one from Mitchell-street to Springburn, with a branch to Maryhill, 6¾ miles of double track; and the other to Springburn and Dennistoun, from St. Vincent-place only. The tube pole, he thinks, should not be used, the Milliken lattice-pole being far preferable. The *Herald* continues: "Whatever firm or company the Corporation employ to equip the electric lines, it would be well to get the firm either to guarantee that the working expenses shall not exceed a certain sum per car mile—say, for the first three years—or else get the firm to work the routes for such a period of time for a fixed remuneration. This would at once test exactly what the electric men are prepared to do in this country. It will be remembered that the Town Council got a guarantee for accumulator traction, and even with that they have not yet adopted it. The accounts, of course, should be under the superintendence of the Tramway Trust's accountant. In passing, we would say that the Trust should not definitely abandon all thoughts of electric accumulator traction. The enormous advantages of that system for quiet level routes, and in residential districts where no other system is practicable, have frequently been emphasised, and they should not be forgotten. We have mentioned some reasons for the especially bad results in Birmingham, and we think many of the causes are avoidable. The Electric Power and Traction Company of London still adhere to their offer to run accumulator cars at a haulage charge of 4½d. per car mile in Glasgow, or nearly 1½d. per car mile less than horse haulage presently costs. This is a guarantee, and cannot be lightly pooh-poohed. The stoppage of their small installation of cars in London has really nothing to do with the question. The cars were run to give the company information upon which to base contracts and offers, and that information having been got, their purpose was served. We therefore hold, especially in view of improvements always going on, that the Tramway Trust should not lose sight of the Electric Power and Traction Company's offer. Perhaps the Trust's hands will be full enough meantime with other work, but the turn of the accumulator ought to come. In this connection it should also be noted that the Electrical Power Storage Company, who manufacture accumulators, have now begun to advertise that they are prepared to undertake the maintenance and working of approved tramways equipped with self-contained electric cars at rates from 55 to 65 per cent. of the gross receipts. This is so good an offer that tramway authorities cannot afford to ignore it. It means a working expense of from about 10 to 20 per cent. less than the cost with horses. Glasgow has many lines suitable for accumulator traction, so that the Trust ought really to reconsider the matter. Enquiry can do no harm, and possibly Birmingham experience may only be a stepping-stone to success. We believe the idea of the Trust at present is that they can be getting the power station erected for the trolley wire lines, the machinery placed, and the poles set up, so that when the tramway company's lease expires in 1894 the electric line may be started with little delay. But the same course is open in regard

to the cable system. It appears that the Trust are still somewhat dubious as to the initial cost. In the end of last year the Tramway Committee obtained from Messrs. Dick, Kerr, and Co., the constructors of the London and the Edinburgh cable lines, an estimate of the total cost of constructing and equipping five miles, double track (equal to 10 miles single), on the cable system. The estimate was as follows:

Track, tube, and pulleys complete	£85,000
Engine room, machinery, stable, etc.	9,250
44 gripper cars (dummies)	5,280
Total	99,530

This included track rails and the causeway setts. If the Corporation supplied these the estimate would be reduced to £79,530. It did not include land. The same firm have just put in an estimate for another town for the conversion of 2½ miles, double track, from steam to cable. The equipment includes 20 large bogie cars with grippers on the platforms, and the estimate, including engine and boiler house, etc., complete, is £53,000. A large proportion of the existing track rails and setts will be used again. Now both here and in the case of the Glasgow estimate there is further proof that the cable system costs very little more than a horse installation for a heavy traffic, such as a car every two minutes. All who sympathise with the solid claims of cable traction will be glad that the Tramway Trust are seriously thinking of giving it a trial. We are convinced that with wise engineering, construction, and management nothing more is necessary, and we look forward to the time when Glasgow will have a system of cable roads comparable to some of those in America. We have dealt with the present position of the electric accumulator system in England. We have shown the great success of cable traction at home and abroad. The more or less dubious condition of electricity with the overhead wire for a fair traffic, together with its low first cost and efficiency as far as experience goes for suburban lines, have been pointed out. Its absolute unsuitability for heavy city work has been demonstrated. The position and prospects of mechanical power for British tramways have been sketched, and a glance has been taken at new inventions. The work to be done in making a change to the electric and the cable system has been indicated. All these studies point unmistakably to one conclusion, which may be briefly expressed in the phrase—cable for the city, electricity for the suburbs."

PROVISIONAL PATENTS, 1892.

OCTOBER 24.

19025. **Electricity meters and improvements therein.** Arthur Wright, 26, Park crescent, Brighton.

19061. **Electric railway systems.** William E. Irish, 9, New-inn, London. (Complete specification.)

19062. **Improvements in means or apparatus for enabling electric current to be derived from an incandescent lampholder and conducted to a lamp or other electric apparatus at a distance therefrom.** Sidney Alfred Hunter, 23, Southampton buildings, Chancery lane, London.

19076. **Improvements in or relating to microphone carbons.** George Septimus Hooker, 27, Martin's lane, Cannon street, London.

19077. **Improvements in or connected with mains or conduits for electric cables.** Joseph Aird, 27, Southampton buildings, Chancery lane, London.

OCTOBER 25.

19127. **Improvements in electric arc lamps.** George Joseph Philpott, 48, Gloster road, Brighton.

19146. **Improvements in insulators for electrical and other purposes.** Henry Harris Lake, 45, Southampton buildings, Chancery lane, London. (Johns Pratt Company, United States). (Complete specification.)

19169. **Improvements in or connected with telephone receivers.** William Phillips Thompson, 6, Lord street, Liverpool. (George Vaughan Benjamin, United States.) (Complete specification.)

19170. **Improvements in the production of chlorine soda, and other products by electrolysis, and in apparatus employed therein.** Henry Blackman, 55, Chancery lane, London.

19172. **Improvements in electrical apparatus for lighting and extinguishing gas lamps, and for indicating automatically whether the gas is lit or extinguished.** Axel Orling, 4, South street, Finsbury, London. (Complete specification.)

19184. **An improvement in incandescent electric lamps.** Oliver Imray, 28, Southampton buildings, Chancery lane, London. (The Westinghouse Electric and Manufacturing Company, United States.)

19194. **Improvements in telephones and in the application thereof to railway signalling.** Charles Langdon Davies, 24, Southampton buildings, Chancery-lane, London.

OCTOBER 26.

19222. **An improved apparatus for the production of electric currents, alternating in direction with great frequency.** David Salomons and Lazarus Pyke, 33, New Tothill street, Westminster, London.

19220. **Improvements in electric batteries.** Edwin Freund, 63, Queen Victoria street, London. (Ernest Freund, Austria.)

19236. **Improvements in and relating to the generation and distribution of electrical energy.** George Wilkinson, Mansfield House, Southport, Lancashire.

19242. **Improvements in cases for containing electric batteries and the like.** Alfred Oblasser and Charles Terry, 43, Southampton buildings, Chancery lane, London. (Date applied for under Patents Act, 1883, section 103, 2nd April, 1892, being date of application in France.)

19248. **Improvements in conduits for electrical conductors.** Charles Edmund Webber, 70, Chancery lane, London.

OCTOBER 27.

19282. **An improvement in or connected with galvanic batteries.** William Walker, 128, Colmore row, Birmingham.

19293. **Improvements in electric lock and alarm.** Robert Baumann, 52, Chancery lane, London. (Complete specification.)

19303. **Improved means for transmitting telegraphic signals through submarine and like cables.** Edward Henry Draper, 124, Chancery lane, London.

OCTOBER 28.

19385. **Improvements in or relating to the distribution of electrical energy and in maintaining the potential thereof.** William Lowrie, 433, Strand, London.

19386. **Improvements in or relating to the supply of electrical energy for propelling or lighting purposes upon electrical railways.** William Lowrie, 433, Strand, London.

19387. **Method of increasing the speed of signalling in submarine or subterranean cables, and the construction of such cables for this purpose.** Siemens Brothers and Co., Limited, 28, Southampton buildings, Chancery lane, London. (Messrs. Siemens and Halske, Germany.)

19393. **Improvements in electric battery apparatus.** Thomas Froggatt, 55, Chancery lane, London.

19404. **Improvements in or relating to safety cut outs for electric generators, transformers and motor generators coupled in parallel.** John Smith Raworth, 6, Lincoln's-inn fields, London.

OCTOBER 29.

19451. **Improvements in voltaic batteries, electrodes, and connections.** Henry Francis Joel, 44, Lavender grove, Dalston, London.

19478. **Improvements in electrical apparatus for increasing the adhesion of the wheels of engines on railway rails.** Adrien Palaz and Victor Duboux, 45, Southampton buildings, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1891.

17220. **Commutating electric currents.** De Ferranti.

18256. **Electro deposition of metal upon the surface of glass, etc.** Ford. (Pottier.)

19020. **Telephonic switching apparatus.** Bennett.

20545. **Telephonic exchange signalling.** Bennett and McLean.

21018. **Electric arc lamps.** Schmidt.

21154. **Electrical lampholders.** Snell and others.

21246. **Dynamos.** Munro.

21399. **Secondary batteries.** Lake. (Müller.)

22404. **Coupling electric mains.** Bowden and others.

22695. **Electrical circuits.** Imray. (Westinghouse Electric and Manufacturing Company.)

1892.

11320. **Telephonic apparatus.** Vogt.

11426. **Electric switches, etc.** Dymond. (Strowger and another.)

13380. **Telegraph cables.** Bedwell.

15179. **Arm rests for telephone operators.** Bailey and others.

15833. **Telegraphic apparatus.** Thompson. (Bell.)

15864. **Electrical switches.** Atkinson.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	[illegible]
Brush Co.	—	3¼
— Pref.	—	[illegible]
City of London	—	[illegible]
Electric Construction	10	3¼
Gatti's	—	[illegible]
House-to-House	5	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]
London Electric Supply	[illegible]	[illegible]
Metropolitan Electric Supply	—	[illegible]
National Telephone	[illegible]	[illegible]
St. James	—	[illegible]
Swan United	[illegible]	[illegible]
Westminster Electric	—	[illegible]

NOTES.

Antwerp.—The contract between MM. Van Rysselberghe and Moris and the town of Antwerp was signed last week.

Swiss Telephones.—The length of the wires used by the various telephone systems in Switzerland is given as 13,340 miles.

Personal.—Mr. Sidney Hargreaves, consulting electrical engineer, is leaving for the Cape for the winter on account of ill-health.

Tempered Copper.—Over 500 different patterns of commutator bars and segments are now made by the Eureka Tempered Copper Company of America.

Degrees.—The course in electrical engineering is now acknowledged as part of the work leading to the Ph.D. degree in physics at the Johns Hopkins University.

Indian Telegraphs.—The Government of India have sanctioned the construction of a line of telegraph from Srinagar to Astor, by way of the Stragbad and Burzil passes.

Electric Railroad.—Mr. H. Ward Leonard is busy constructing an interesting electric railway for passengers and heavy goods traffic between Johnstown and Gloversville, New York.

Electric Motors.—Prof. Crocker, who has means of judging, says there are between 50,000 and 100,000 electric motors now in use in the States, as against about 1,000 only in the whole of Europe.

Belgian Exhibition.—The proposal, it is stated, has now been definitely adopted to hold the Belgian International Exhibition of 1895 in two sections—the one at Brussels and the other at Antwerp, the two parts being connected by an electric railway.

Berlin.—A report by Herr Cuno states that Berlin is now lighted by 2,916 electric arc lamps and 67,459 incandescent lamps. In addition to these there are 253 private installations—170 driven by steam and 83 by gas—which supply 3,287 arc lamps and 40,801 incandescent lamps.

Terrestrial Magnetism.—A French officer, M. Ribard, propounds his theory that the terrestrial magnetism is due to earth currents engendered day by day by the solar heat travelling round the globe, and that these currents being from east to west produce the magnetic effect.

Stealing Lamps.—The Southend piermaster has evidently been troubled with purloiners of incandescent lamps, for he reported at the last Board meeting that, amongst other articles missing, he had found 10 incandescent lamps missing from the wings, two from the lavatories, and five from the orchestra.

Meteorology.—At the meeting of the Royal Meteorological Society on the 16th inst., a paper will be read on the "Thunderstorm, Cloudburst, and Flood at Langtoft on July 3," by John Lovel, F.R.Met.S., and "On the Measurement of the Maximum Wind Pressure, and Description of a New Instrument for Indicating and Recording the Maximum," by W. H. Dines, B.A., F.R.Met.S.

Niagara.—Among the plans under consideration for the electrical transmission of power from Niagara are those of the Oerlikon Company; Brown, Boveri, and Co.; the Compagnie de l'Industrie Electrique, of Geneva; the General Electric Company, of New York; and the Westinghouse Company, of Pittsburg. No decision as to the system to be used has yet been definitely made.

Graphite.—If engineers knew all the good qualities of graphite, there would be twice the demand, thinks a technical correspondent. Mixed with oil drippings and smeared on bolts it effectually prevents rust even in the dampest places, but the graphite must be of good quality. It may be used for pipe joints, cylinder heads, and piston-rod packing, besides the lubrication of bearings.

North-East Coast Engineers.—On Saturday, a general meeting of the North-East Coast Institution of Engineers will be held in West Hartlepool, when papers "On the Combustion of Coal and Prevention of Smoke" will be read by Mr. J. R. Fothergill, vice-president; and "On a System of Mechanical Aid to the Investigation of Speed Curves," by Mr. J. Denholm Young, Wh.Sc.

Aluminium.—The Aluminium Company will soon have to change its name to the Sodium Company, it would appear. The trade in aluminium has been entirely revolutionised by electricity, and instead of selling at 20s. a pound, this metal is now supplied at 2s. The company have gone in for the production of sodium at their Oldbury works, and have been sufficiently successful to induce them to extend the works.

Rival Illuminants.—The chairman of the Southampton Gas Light and Coke Company, at the half-yearly meeting last week, said the company were not at all afraid of the electric light; the fact that they had increased the sale of gas by 4,500,000 cubic feet during the half-year proved that it had not injured them, and it appeared to him it was only one illuminant added to those already in use, and that there was plenty of room for all.

Southend Pier.—The Southend Committee have recommended that a sum of £5 should be divided between the two drivers of the electric cars on the pier for the efficient way in which they have driven the cars without accident during the season. It seems that last year there were several accidents, and the Pier Committee considered the matter, and thought it would be policy to hold out some inducement for the men to run with carefulness.

Technical Education. — An architect has been appointed by the Dunfermline School Board to prepare plans for a proposed technical school at a cost of about £4,000. A number of classes, which will be incorporated with the technical school, are at present being conducted, and it has been agreed to open a preparatory class in chemistry, and to appoint Mr. E. N. F. Hamilton, of Glasgow, teacher of steam and applied mechanics.

Trinity Engineer.—It was generally expected (says the *Observer*) that Sir James Douglass's successor as chief engineer at Trinity House would have been his son, who has aided him in several of his works, notably in connection with the Eddystone Lighthouse; but the choice of the Brethren has fallen upon Mr. Matthews, who was assistant to Sir James for many years. Mr. Douglas, however, becomes consulting engineer, with the reversion of the higher post.

Simla.—The question of lighting Simla with electric light, says the *Indian Engineer*, is under consideration, and it is proposed, if a practicable scheme is prepared, to form a company to carry it out. One of Messrs. Siemens's engineers has been examining the project for drawing the requisite power from the Sutlej; but on account of the expense this project is likely to be given up in favour of another, which would draw the power from the municipal water works.

Original Research.—The Royal Institution has received a grant from the Goldsmiths' Company "for the continuation and development of the valuable original

research which the society is engaged in carrying on; and especially for the prosecution of investigation on the properties of matters at temperatures approaching that of the zero of absolute temperature." A donation of £50 has also been received from Mr. F. D. Mocatta for carrying on investigations on liquid hydrogen.

York Courts of Justice.—The wiring of the new courts of justice at York for the electric light has just been completed for 450 lights. The work has been carried out by Messrs. Benham and Sons in a very satisfactory manner under the superintendence of Mr Sidney Hargreaves. The York Corporation are now putting down an 18-h.p. Otto gas engine to drive a Crompton dynamo, to light simply the police department, the prison cells, and fire station. The remaining portion of the building is not to be lighted until the general town lighting is complete, the tenders for which have been already received.

Train Lighting.—It is a great pity that the efforts of electrical engineers, given for so long to miners' lamps and omnibus lighting, cannot be turned seriously to tackling the problem of train lighting by separate lamps. In several cases trials have been made by the railway companies with dynamos carried on the train but these have not always achieved continued success. An instance of this is given on the Penarth section of the Taff Vale Railway, where it was found the distances between stations was too short to allow sufficient electricity to be produced to supply a good light when the train was at a standstill, and a return has been made to oil and gas.

Liverpool Overhead Railway.—The first train on the Liverpool Overhead Electric Railway was run on Tuesday, carrying the directors and their friends. The trip was very satisfactory, the behaviour of the main engines and dynamos being all that was anticipated, and the experiment indicated a very successful issue. There were present the chairman of the railway company (Sir William Forward) and the whole of the directors, as well as Mr. J. H. Greathead and Mr. Francis Fox, the engineers. The contractors (the Electric Construction Corporation, Limited) were represented by Mr. Thomas Parker, who received the congratulations of the whole of the party.

Lord Kingsburgh on Electricity.—On Monday, Lord Kingsburgh delivered the opening lecture of the Armitstead Course in Dundee, on the subject of "Electricity: Where Found, How Got, To What Ends." He was glad to learn that Dundee was to be the first large city in Scotland that would be thoroughly equipped with electric light. He hoped it would not be long before the inhabitants of Dundee would have something better to move their tramcars along than steam engines, because, in his opinion, they wanted cleaner and better power for the purposes of street locomotion. They in Edinburgh would live in hope, and he trusted the example of the city of Dundee as regards electric lighting would be very rapidly followed there.

Westinghouse Lamp.—The new Westinghouse lamp, about which so much is being said in America at the present moment, is understood to be a stoppered lamp with the holder and filament fitting into the bulb like the conical stopper of a chemist's bottle. It has been well tested, and the company promise satisfaction. This construction, it is maintained, will avoid the Edison patents, and is protected itself by the old Sawyer-Man patents, besides other newer patents owned by the Westinghouse Company. The result of this unexpected move on the part of the Westinghouse people will be watched with keen interest on this side, though there is hardly likely to be such spirited controversy between the owners of patent rights here as in the States, where already a large number of manufacturers are interested in the production of incandescent lamps.

Gas Supply to Electric Customers.—It will be remembered that the Carlow Gas Company took energetic action by refusing to supply gas to several householders who substituted electric light for gas in the lighting of their houses. Though not using the gas, they preferred to keep the meters, so as to be able to fall back upon the gas in case of a failure in the electric supply. At the Carlow Quarter Sessions the gas company brought an action against a householder to compel him to give up the meter, as it was the property of the company. The county court judge, without deciding the question that had been raised as to the right or wrong of the company refusing gas to the private consumer when he pays for what the meter registers, dismissed the case on the ground that the company had no right to remove the meter until they had first cut off the connection with their mains.

Separable Lamps.—The attention that is being drawn to the design of incandescent lamps so constructed that the filament can be removed and renewed will cause interest to be given to the new lamp of Mr. Frank Smith, superintendent of the lamp department of the Westinghouse Company. He has found that certain compounds of the alkaline with the silicon group of elements may be used to form the carrying stem. These compounds are soluble in hot water, and at the same time they have certain physical characteristics that enable them to unite with the wire under the influence of heat, making an airtight joint, and they also unite with the glass. In this way is formed a composite bulb, partly of glass, the remainder being soluble. Mr. Smith finds that the selection of the best compound depends largely on the composition of the glass. The greater the proportion of the alkali with reference to the silica, the softer will be the resulting compound. The compound, $4Na_2O.5SiO_2$, makes a perfect union with platinum wires, and will also unite with glass having a sufficiently low fusing point.

Reconstruction.—A legal point involving the meaning of the term "reconstruction" of a company came before Mr. Justice Chitty, in the High Court of Justice, last week, in the case of Hooper v. Western Counties and South Wales Telephone Company, Limited. The defendant was holder of nine £100 debentures, bearing interest at 5 per cent. These were redeemable at par in 1890, but there was a proviso that the defendant company might, at any time after the expiration of one year from the date of the debenture, redeem the debenture by giving three calendar months' notice to the holder, and paying to the holder £105 for every £100 capital secured with interest up to the date of payment. There was also a further condition that, if the defendant company commenced to be wound up "otherwise than for the purposes of reorganisation or reconstruction," the principal money secured by the debentures was to become immediately payable. The company amalgamated with the National Telephone Company in 1892, and all the debenture holders agreed to the proposed exchange except holders of £1,[illegible] among which was the plaintiff. Mr Justice Chitty took the view that the company had not undergone reconstruction, and dismissed the plaintiff's proceedings with costs.

Electric Photography.—Prof. W W Jacques, in a lecture before the German Technical Society of Boston, relates his experience in witnessing the operation of sending photographs over a wire by means of electricity. Without giving details of the apparatus employed, which he evidently believes to be genuine, he says "The laboratory consisted of two rooms. In one was an ordinary

photographic camera, a small developing-closet, and a table on which was a cubical box, having on one side a slit of sufficient size to receive a postal card. From this box two wires stretched across the room, and, passing through the wall, extended to a similar cubical box in the next room. I was given an ordinary postal card and asked to write a short note on it, and wrote, 'Good morning! How do you do?' This my friend photographed by electric light, developed, and dropped the hastily-made negative into the slit in the cubical box in the middle of the room. I went into the adjoining room, and there, issuing from the corresponding box on the table, was a piece of thin paper the size of the card, on which appeared a *fac-simile* of the words I had written: 'Good morning! How do you do?'" There would seem no reason, adds Prof. Jacques, why the sending and receiving boxes, instead of being in adjoining rooms, should not be placed one in Boston and the other in New York. The professor adds that he has spoken by telephone between Boston and Chicago, a distance of 1,200 miles. He looks with confidence to the development of a means of electric signalling between vessels at sea, and with anticipation to the discovery of a means of converting the energy stored in coal direct into electrical energy.

French Submarine Cable.—Some few particulars may be interesting of the submarine cable between Marseilles and Oran, manufactured and laid by the Société Générale des Téléphones of Calais—the first telegraph cable made in France. The core is formed of a seven-strand copper cable, weighing 48 kilogrammes (105·6lb.) per nautical mile, with the resistance, at 24deg. C., not exceeding 12 ohms. The insulating envelope is composed of three coatings of guttapercha, alternating with Chatterton's compound. The first coating of compound is placed on the copper core. The insulation weighs a minimum of 63 kilogrammes (138·6lb.) per nautical mile. After 24 hours' immersion in water at 24deg. C., the insulation test was to be between 300 and 1,500 megohms per nautical mile after two minutes of charge for both positive and negative charge, and after embarking was to be not less than 500 megohms per nautical mile. The cable was tested with 200 Daniell cells. The capacity per nautical mile was not to exceed 0·36 of a microfarad. The deep-sea part was armoured with 15 galvanised steel wires of 2½ mm. diameter; the wire to offer a breaking resistance of 78 to 80 kilogrammes, so that the cable had a breaking resistance of 5½ tons. The intermediate portion had 10 wires of 5 mm. diameter, the cable to offer a total resistance of 7½ tons; and the shore end had the same cable as the deep-sea part, covered with a serving of jute, and covered with a second armour of 11 large galvanised iron wires 7 mm. diameter, the total resistance to rupture being 22 tons. The cable was laid by the "François-Arago," on August 30th to September 3rd, the Société Générale des Téléphones thus successfully carrying out their first cable-laying operation.

City Lighting.—Complaints are being already made, we are told, in the City with reference to the charges for electric lighting from the mains of the City of London Company. We are not by any means convinced that there are fair grounds for these grumbles. The company have a great work before them, and are entitled to make conditions of use at first that may be possibly modified a little later on. It is complained that the work of installation is too much divided, and increases the expense to the consumer. The only division is between supply company and contractor. The fitting by the supply company itself is open to abuse, and has never been favourably regarded in this country. The charge of 8d. a unit is high, as things go, but every charge is high in the City; probably, however, it will eventually be reduced. The charge for meter rent is a necessity—persons would not like to take their supply without a meter. The condition that at least four lamps must be taken is evidently a wise one for a new undertaking, where the cost of laying on has to be considered, and the price for fitting for lamp and wiring complete at 30s. a lamp certainly does not seem an excessive amount. A firm who wished to save expense might do well to call in the services of an experienced expert, who for a moderate fee would arrange his lighting in 8, 16, 30, or 100 c.p., to save much expense both in first cost and in expenditure for current and lamp breakage, for this can be done to a much greater extent with electric light than some contractors are willing to believe. But beyond this we cannot acknowledge that the objections of City men to the expense of the electric light are tenable. The advantages they all know and, we hope, will soon experience.

The New York and Chicago Telephone.—The world has grown so accustomed to electrical marvels that the opening of a telephone line between New York and Chicago, a distance of very nearly one thousand miles, passes almost unheeded amongst the rush of other novelties. Even this enormous speaking distance is not the largest that has been successfully attempted, for speech has been transmitted between Boston and Chicago, a total of 1,200 miles. The noticeable feature of the New York and Chicago line was the quietness and absence of all induction and the clear-cut quality of the words, although the sound appeared only half as strong as on the short lines. The line is built of two No. 8 hard-drawn copper wires carried along parallel with each other, and transposed at certain intervals, or crossed diagonally without touching, in a kind of long spiral, creating electrical balance of induction. There are 45 poles to the mile, 35ft. high, the total number being 42,750. The distance is 950 miles, and there are 435lb. of wire to the mile, a total weight of 826,500lb. An important element in the success is the battery, which must be capable of maintaining constant high pressure for an extensive period. An improvement on the Fuller battery is used, consisting of a glass jar with a solution of bichromate of soda and sulphuric acid, made in the following proportions: Water, 10 gallons; commercial sulphuric acid, 25lb.; and bichromate of sodium, 8½lb. In the bottom of the porous cup is placed mercury, an amalgamated plate of zinc, and a saturated solution of common salt; a large plate of carbon forming the other pole. A wood cover prevents evaporation. The action of long-distance transmitters has also, it is stated, been improved by using a uniform size of carbon granules, sifted through a mesh. Chicago is shortly to be connected to Milwaukee and other cities.

Westinghouse Alternator.—A 500-h.p. alternator has been erected by the Westinghouse Company at Providence, working at 2,200 volts, with a guaranteed efficiency of 92 per cent. It is coupled direct to the horizontal engine, which runs at 90 revolutions only, and the armature, in order to comply with the new standard of 7,200 alternations, was made 16ft. in diameter. It is built up of wrought-iron E-shaped plates bolted to a heavy cast-iron flywheel. The projecting teeth are of T-shape and form pole-pieces, each tooth being surrounded by a simple lathe-wound coil held in position by insulating wedges driven in between the coils beneath the T-edges. The insulation of the machine is very high, being made safe for 20,000 volts. Any single coil can be replaced without disturbing the others. There is a small air space, ⅜in., between pole-pieces and surface of armature. The fluctuations of current

in the fields is secured by the use of two transformers placed diametrically opposite on the hub of the shaft, they are in multiple series, with the main circuit and their secondaries, one connected with a commutator on the shaft. The rectified currents thus derived varies with the load of the generator, for if the load is increased there is an additional flow of current on the mains, and a drop in the potential of the generator; the increased current sent through the primary of the transformers increases the secondary—that is, the rectified current—and as this latter is used to partially excite the fields of the exciter, the E.M.F. of both exciter and generator are raised, thus counteracting the drop on increased load. By this peculiar arrangement, an easy automatic regulation of the 500-h.p. alternator is obtained. The collecting rings are 28in. diameter. There are two sets of brushes—two for rectified and two for alternating currents. The field is supported on slides, and by means of screws can be moved along to give easy access for inspection and repairs.

Bradford Great Northern Hotel.—The Victoria Hotel, Bradford, has just been opened with some ceremony after its purchase and reconstruction by the Great Northern Railway Company, at a cost of about £40,000. From being a dingy and old fashioned hotel, it has blossomed forth into a magnificent and luxurious resting-place—one of the finest of the provincial hotels. Besides being artistically appointed and lighted throughout by electric light, some novel arrangements have been made for passengers' comfort. Among these is a mechanical apparatus for transferring luggage direct from the station to the bedrooms. Another great convenience is an indicator connected to the signal-box, which shows automatically, five minutes prior to the arrival of a train, the last station left, and the starting town—London, Liverpool, or Manchester, and so forth. The principal apartments on the ground floor include a large coffee room, a reading and writing room for general visitors, a similar room for business men, a stock-room for commercial travellers, and a billiard-room, with smoking-room adjoining. The large coffee-room has a floor of oak parquette walls panelled with a high dado of oak, ceiling treated in fancy plastering with an ornamental gold frieze, and the windows of stained glass; and the artificial lighting is by means of 83 electric lamps, each of 16 c.p. The reading and writing rooms close by and other rooms on the ground floor, including the billiard room, are similarly decorated, the billiard room being roofed with handsome stained glass. The balustrade to the staircase is of wrought iron, gilded and lacquered, and the ceiling is of a rich gold pattern. The hotel contains ladies' drawing-room, with the sitting rooms and private dining-rooms, on the first floor. There are in all 100 bedrooms, varying in size, the whole being lighted with electric light. There are nearly 600 lamps in all throughout the building, and the arrangements in every way reflect great credit on the enterprise of the railway company.

Society of Arts.—The opening address of the one hundred and thirty ninth session of the Society of Arts will be given by Sir Richard Webster, Q.C., M.P., chairman of the council of the Society of Arts, on Wednesday, November 16, at 8 p.m. Previous to Christmas there will be four ordinary meetings, in addition to the opening meeting. Mr. James Douglas will read a paper on "The Copper Resources of the United States," on November 30; and Mr James Dredge one on "The Chicago Exhibition, 1893," on December 7. At subsequent meetings, the dates of which are not yet published, papers will be read by Prof. George Forbes, F.R.S., on "The Utilisation of Niagara", Mr. Bennett H. Brough, "The Mining Industries of South Africa"; Prof. Francis Elgar, LL.D., "Transatlantic Steamships"; Prof. Frank Clowes, D.Sc., "The Detection and Estimation of Small Proportions of Inflammable Gas or Vapour in the Air"; Mr William Key, "The Purification of the Air Supply to Public Buildings and Dwellings"; Sir William Wilson Hunter, K.C.S.I., C.I.E., LL.D., "Ten Years of Progress in India"; Sir Edward N. C. Braddon, K.C.M.G., Agent-General for Tasmania, "Australasia as a Field for Anglo Indian Colonisation"; Sir Juland Danvers, K.C.S.I., late Public Works Secretary, India Office, "Indian Manufactures"; Mr. Edward J. Howell, "Mexico—Past and Present"; Mr Cecil Fane, "Newfoundland"; Mr. W. B. Percival, Agent-General for New Zealand, "New Zealand." The following courses of Cantor lectures will be delivered during the coming session of the Society of Arts: Prof. Vivian Lewes, "The Generation of Light from Coal Gas and its Measurement," on Nov. 21, 28, Dec. 5, 12; Dr J. A. Fleming, "The Practical Measurement of Alternating Electric Currents," on January 30, February 6, 13, 20; Prof W. Chandler Roberts-Austen, C.B., F.R.S., "Alloys," March 6, 13, 20; Mr. Lewis Foreman Day, "Some Masters of Ornament," April 10, 17, 24, May 1; Mr. C. Harrison Townsend, F.R.I.B.A., "The History and Practice of Mosaics," May 8, 15.

The Swiss Telephone System.—The American Consul-General at St. Gall describes the Swiss telephone system in a recent report as the best and cheapest in Europe. It is owned by the Central Government, like the telegraph system, and is under the control of the Department of Posts and Telegraphs. This has proved an advantage to the public, as the service is better and cheaper, the rates being lower than anywhere else in the world. In 1880 the first telephones were used in the country by a private company. This was at Zurich, the concession being for five years, the total number of instruments in use being only 144. Zurich only has now [illegible]. In January, 1886, the Government took over all the telephones, and in that year the profits came to 130,000f., in spite of reduced rates to subscribers and the expenses incidental to acquiring private rights. In 1887 the number of subscribers increased to 6,000, and long distance telephones connecting the Swiss cities as well as places in Germany were introduced. In 1888 the profits grew with the ever increasing extension of the system, and since that time the accounts have been merged in those of the telegraphs. The usual charge for subscribers is about £5 for the first year, £4 for the second, and about £3 thereafter. Eight hundred calls a year are allowed to each subscriber, all calls beyond this number being charged at a halfpenny each. Telegrams are received and delivered by telephone at a penny each, and as many of the telegraph and telephone offices are combined, and as many of the telegraphists are also telephone operators, the advantages and the economy are considerable. "The employés are better trained than in private companies, because their positions are secured to them, and there is a consequent natural pride in having their service good. Government responsibility, too, assures prompt attention, and, it is universally acknowledged in Switzerland, the management by the State has resulted in economy and a perfect service. Like the post and the telegraph systems of the country, the telephone system is owned by the people, and the State manages it with a single eye to the public good."—*Times.*

Henley's Cables.—The Henley's Telegraph Works Company received in 1885 the distinguished honour of the award of the only gold medal at the International Inventions Exhibition, and although this epoch-making year for electrical science is fast fading in the distance of the decade,

during which the most remarkable progress has been made in every direction, we find the celebrated Henley's Telegraph Works always keeping pace with the development of the industry. Their catalogue for October, 1892, just issued, though concise and statistical, probably contains the symbols of more carefulness, scientific accuracy, and thought than most other price-lists of articles supplied in the electric trade. It is a standing reminder of the way in which the trades depend upon one another to reflect upon the work which has to be put into this part of an electrical installation before it comes into the hands of engineers and contractors. Electrical engineers may make their own dynamos, switches, even engines, but not their own wire and cables. The company, known to all as Henley's, started in the very earliest days of telegraphy, has kept pace step by step with the demands of science and of commerce in their particular field, and the result is embodied in their catalogue of electric light wires and cables. The first class of electric light conductors is with insulation of vulcanised india-rubber taped; next, vulcanised rubber taped and braided; both types in three classes: 300, 750, and 2,000 megohms insulation resistance to the mile. The third kind of insulation is of pure rubber braided and compounded, one or more coats of pure rubber and braided, or with coat of felt and then braided. Details of the twin flexible cords are also given, as well as jointing material and wood casing. Separate lists, we may mention, are issued by Henley's Telegraph Works Company for concentric cables, lead-covered cables, steel-armoured cables, telephone cables, paraffined line wires, as well as for cotton and silk-covered wires for dynamos and instruments. The company draw the attention of those specifying for wires or cables to the importance of mentioning the thickness of both insulating material and outer serving for important cable contracts.

Allgemeine Company's Catalogue.—A very beautifully-printed illustrated catalogue has reached us from the Allgemeine Elektricitäts Gesellschaft of Berlin. This company, which is one of the best known and largest continental electrical engineering concerns, has branches at Breslau, Frankfort, Hanover, Cologne, Leipzig, Munich, Nuremberg, London, Madrid, and Bucharest. The work they undertake is generally of the largest and highest class, and comprising electric lighting, central station and other electric transmission of power, and the electric driving of machine tools, cranes, and other heavy machinery. The special types of high-speed and compound engines they employ in their installations are illustrated, as well as the various forms of dynamos and motors, types of which have been on show at their London branch, the Electrical Company, Limited, Charing Cross-road. The "Tudor" accumulator appertains to the Allgemeine Company, and is shown as used for electric lighting installations, or for tramway traction. Some very fine switchboards appear, as naturally becomes a company who have fitted up some of the largest central stations in the world, and measuring instruments of various kinds are represented. The company patronise the "Aron" meter and the Edison fuse plugs, and show a number of useful combinations of this latter. The "A. E. G." branch switch is of the quick-break type, and wall sockets of screw and plug kind, together with casing, sockets, and other fittings are illustrated in profusion. The "A. E. G." incandescent lamp is made by the company in the usual shapes and candle-powers. Arc lamps and standards, with swinging arms and other devices for lowering the lamps, illustrate street lighting, and then we come to some very interesting examples of the application of electric motors in the different branches of commercial and engineering work. Boring machines, both fixed and movable, are illustrated, and a fine full-page illustration of the company's engineering shop shows the portable boring machine in action. A lathe electrically driven is also shown, with an armature mounted as used in the works. An electric lift driven by one of the "A. E. G." motors, a huge electric carrying crane, and, finally, an electric discharging crane on the dockside, complete an illustrated review of work carried out by the Allgemeine Company which is an important demonstration of the extent of their productions in heavy electrical engineering.

Electric Lighting in Belfast.—Mr. John H. Greenhill, M.I.E.E., delivered a lecture, which was greatly appreciated, on "The Subject of Electric Lighting," in Belfast last week to a large and influential audience. The subject is a burning one in Belfast, and the lecturer was supported by Mr. Jas. Perry, C.E. (brother to Prof. Perry), Mr. J. Milne Barbour, and others, while the chair was taken by Prof. FitzGerald. Sir Jas. Haslett, Dr. Cecil Shaw, and many of the most influential men of the district were present. The lecturer gave a brief sketch of the history of electric lighting, illustrated with photographic lantern slides. He described the recent progress that had taken place in the introduction of the three-wire system and of high-tension transmission. He considered the continuous-current system would be best for Belfast, using storage batteries. He then proceeded to give a number of figures and details with reference to the proportionate cost. His conclusion was that 500 electric incandescent lamps lighted for 450 hours a year would cost £144. 17s. 6d. in a mill or works where more engineering power could be used for driving the dynamos. If the arc light could be used, as it could in the case of factories or shops having high ceilings and large space, the cost would not be more than half that amount. The cost of 500 gas lamps of equal value, basing the calculation on an expenditure of six cubic feet per hour for each lamp, and the price of gas at 2s. 7d. per 1,000ft., would be in the same amount of time—450 hours per year—£174. 7s. 6d.; and, adding £8 for incidental expenses, such as removal of burners, would bring it up to £182. 7s. 6d. Where lights were used for a shorter time, however, the case was very different, and the result came out most unfavourably for the electric light. Take 350 hours a year, for instance, in a shop or place where special power has to be supplied to drive the dynamo, and the cost would be some £220. 12s. And if the supply were taken from a central station the figures were still more startling, for taking it at 8d. per Board of Trade unit—it was contemplated, he believed, to charge 7d. in Belfast—the cost for the current alone for these lamps would be £284. 7s. 6d., and other expenses would bring the total cost up to £356. 7s. 6d., as against £220. 12s. If the consumer put in his own plant for driving the dynamo the cost of gas under similar circumstances to these last-mentioned would be only £165. 12s. 6d. He recommended private installations with gas engines when 40 lights were required for over 350 hours. After the lecture, Mr. James Perry, county surveyor for Galway, gave some account of the lighting in Galway Docks, where they used two arc lamps and some 50-c.p. incandescents. The *Galway Express* was lighted and would soon be run by electricity. Their central station cost £7,000, and costs £100 a year to run, being driven by water power and managed by two men only. Gas for lighting purposes he considered doomed. Mr. J. Milne Barbour gave an account of the use of electric light, 700 lamps, in a spinning mill, where there was a saving of 10d. per light per annum in favour of electric light.

THE ELECTROMAGNETIC THEORY OF LIGHT.*

BY JAMES H. GRAY, M.A., B.SC., PRESIDENT.

In bringing before you the subject of the electromagnetic theory of light, I propose to take up, as concisely and completely as possible in the time at my disposal, the main points in the theory, and the evidence that has been brought forward in support of it since it was first given by Maxwell 27 years ago. Of course it is only possible in this short paper to refer in the briefest manner to even the most elaborate work of some of our greatest mathematicians on this subject.

The motive which first induced the philosopher to postulate some medium which could be supposed to occupy all space, was doubtless the unsatisfactoriness of imagining such a thing as a vacuum. We find, however, that most of our students of Nature since the time of Newton have felt compelled to believe in the existence of an all pervading medium, unless they could reconcile themselves to the idea of action at a distance. Newton himself had undoubtedly a tolerably clear conception of such a medium, for he tries to explain gravitation by means of it, but, as he acknowledged, he had no experimental evidence of his theory, and so did not publish it.

It was left to the great Faraday to deal the death blow to the theory of action at a distance. To him all space in the vicinity of a source of energy was filled with lines and tubes of force. To him these lines and tubes had a real existence, just as the medium which we call ether had. He believed, as almost everyone believes now, that if energy disappears at one place and reappears after some time, it may be short, at another, it must have appeared in the interval at a succession of contiguous points between the two places. The energy must, in fact, have been propagated from the one place to the other, and the vehicle of propagation is the ether.

These splendid ideas were the foundation of the grand system which is now the groundwork of all our dynamical methods. This was the foundation of the splendid work that has since been done in this direction by several eminent mathematicians. They have taught us to look at all dynamical problems in a totally different way; for example, to look upon a wire conveying an electric current not as being wholly concerned in the conduction of the energy. They have shown that the energy is really conducted through the medium surrounding the wire, which only serves to dissipate the energy, and thus the conductor, instead of being the chief thing to be considered, is only of secondary importance. Probably the most extensive and valuable contribution to this theory of energy paths has been made by Prof. J. H. Poynting, eight years ago, in his two famous papers, "On the Transfer of Energy in the Electromagnetic Field," and "On the Connection between Electric Current and the Electric and Magnetic Inductions in the Surrounding Field." In these he not only points out that the energy may be so transmitted, but calculates out the actual energy paths. The work of Prof. Poynting, and the extensive work so powerfully done by Mr. Oliver Heaviside, did a very great deal to further the theory which, it cannot be doubted, Maxwell, but for his early death, would sooner or later have placed upon a strong theoretical and experimental basis.

At the same time, in the rush of enthusiasm with which the theory of an ether has been taken up and that of action at a distance abandoned, it is quite conceivable that we should be inclined to stretch the theory too far. The truly scientific man is almost essentially a rationalist. It seems to be engrained in his nature to try to find a reason for everything. This, no doubt, went a long way to make us give up the theory of action at a distance. It may be asked, however, if some are not pushing the idea of propagation in an ether rather too far. That one ether propagates heat, light, electrical and electromagnetic disturbances we at one time accepted without very much experimental evidence. Now we have ample evidence, but even at first we tried to explain existing phenomena by means of a theory, and did not require to invent both theory and phenomena, as, I fear, is being tried in what I am about to refer to. That the ether also propagates gravitation is very probable. Of late years, however, it has been compelled to do even more than that. In fact, according to some, we are to believe that it is the medium for propagating what are called "thought waves." Now, it would be rash to say that this is impossible, or even improbable, but it is certain that the experimental foundation of the probability of such a theory is practically *nil*. This theory of the propagation of thought waves was put forward for the purpose of explaining on scientific principles phenomena called "thought reading," "transmission of thought from one individual in one place to another in a place far removed from the possibility of direct communication," practised in its latest form by a sect called "Mahatmaists." Certainly, a scientific man, if he believed in this transmission of thought, could not, being a rationalist, attribute this phenomenon to anything spiritualistic, and he therefore must look for the reason of it. If thought transmission does exist (I have never had undisputed proof of its existence), then, certainly, such a theory does seem feasible, but the restrictions placed upon it by the believers in it—which are, in fact, that no one who does not believe in it can practise it—make it seem more or less improbable. The physical conditions necessary to cause thought-waves seem still to be most obscure.

Since energy can be transferred in different forms as energy of heat, light, electricity, magnetism, and electromagnetism, it would be necessary either to assume a separate ether for each, endowed with the suitable properties, or to endow one or more of these ethers with properties which would satisfy all these forms. Obviously if it is possible for one ether to satisfy all the conditions it would be most unscientific to assume more than one. That one ether was sufficient for heat and light had been long established, but to Clerk Maxwell it was left to demonstrate that this ether could also be made to propagate electric, magnetic, and electromagnetic disturbances. That Faraday had already conjectured this, we know, for he expressly says so, and that he found experimental proof is evident from his discovery of the rotation of the plane of polarisation by magnetic lines of force. Following after Faraday, Clerk Maxwell, in 1865, gave, as a result of his belief in the identity of the electric and optical ethers, the "electromagnetic theory of light."

Probably no more seemingly extravagant theory has ever been put forth, and had any but a great mind like Maxwell conceived it, it would most likely have been simply laughed at and passed over. As it was, it was regarded at first, and even till a few years ago, as more or less of a speculation, for, like Newton's theory, it had practically no experimental ground for its foundation.

Maxwell holds in his theory that light is an electromagnetic disturbance, and therefore the ether which propagates light also propagates electromagnetic disturbances. More strictly, the theory indicates a close connection between electric disturbances and light rather than an actual identity. Most believers in the theory now, however, feel convinced that they are actually identical, that light-vibrations are merely electromagnetic vibrations of very high frequency. We have thus an increasing frequency of vibration exhibited in electromagnetic, heat, and light-radiations.

Before going into particulars of Maxwell's theory I shall simply mention the other theories which have been devised to account for the phenomenon of light, and state the chief objections to them.

The emission, or corpuscular, need only be mentioned, as everyone knows that, whether or not the other theories be true, this one most certainly is not.

All the theories worthy of acceptance agree in two important respects—namely, that light is propagated in the form of waves, and that this propagation proceeds by means of transverse vibrations in a certain medium called the ether. The different properties attributed to this medium constitute the differences between the several theories.

The investigation of the true theory of light has occupied the minds of most of the greatest mathematicians since Newton first developed the corpuscular theory. Contemporary with Newton, Huyghens, in the end of the seventeenth century, gave, on the basis of the wave theory,

* Presidential address delivered before the Physical Society of Glasgow University.

a satisfactory explanation of reflection and refraction. His conception of the wave theory, however, was that the vibrations were longitudinal—that is, in the direction of propagation—and consequently he was unable to explain polarisation of light, a phenomenon which he himself discovered.

It remained for Fresnel to suggest that the light-vibrations were transverse, and to apply this assumption with great mathematical power to the explanation of polarisation. With Fresnel's theory, however, a number of unexplained difficulties still remained, the most notable of which was the explanation of dispersion—that is, of the different velocities of light-vibrations of different wave-lengths in the same medium. Cauchy, following Fresnel, assumed that matter was composed of molecules whose dimensions were comparable with the wave-lengths of the light-vibrations, and from this explained dispersion. He also supposed that with very long waves the velocity of propagation is independent of the period. Even with these assumptions, however, a complete explanation of the facts is not obtained. Green, discarding the "coarse-grainedness" of the ether, assumed that it was a continuous homogeneous substance, having the properties of an elastic solid, and applied the dynamics of elastic solids to the explanation of optical phenomena. According to this theory, however, there must be longitudinal as well as transverse waves. The former, therefore, we must assume, cannot affect our eyes as light, and also they must consume only a small fraction of the energy. We must assume for this purpose that the velocity of propagation of longitudinal waves is practically infinite—that is, that the ether is practically incompressible.

Besides not agreeing with experimental facts in the case of light polarised by reflection, Green's theory is in some parts quite inconsistent.

MacCullagh and Neumann, about the same time as Green, gave a theory in which they assumed that the light-vibrations were in the plane of polarisation, not perpendicular to it, as Fresnel held, and as is now pretty generally held, and the electromagnetic theory has proved. Since the velocity of propagation of transverse vibrations is given by $v = \sqrt{\frac{\epsilon}{\rho_1}}$ where v is the velocity, ϵ the modulus of elasticity, and ρ_1 the density of the ether, it will be possible to alter v either by altering both the elasticity and density, or by keeping the one constant and altering the other. Fresnel assumed that the elasticity was constant, and that the density altered with the medium. MacCullagh and Neumann, by assuming the density constant and the elasticity variable, arrived at results similar to Fresnel's.

The theories of Fresnel, Green, Cauchy, MacCullagh, and Neumann, based as they were on a pure elastic solid theory, were faulty in many ways, but have since been more or less modified and improved upon by Lord Rayleigh, Sir Geo. Stokes, Rankine, Lorenz, Kirchhoff, and others.

The theory that has been more satisfactory is one in which there is supposed to be a mutual reaction between the ether and matter. This theory has been worked out in different ways by v. Helmholtz, by Lord Kelvin in his Baltimore lectures, Sellmeier, Lommel, Ketteler, and Voigt. It would take up too much space here to consider even most summarily the several points in all the different theories, and it is, besides, unnecessary, for a detailed account and discussion of them can be found in Glazebrook's admirable "Report on Optical Theories," in the British Association Report for 1885. It must suffice here to state that neither the theories based solely on the dynamics of the ether considered as an elastic solid, nor theories in which the ether and matter are supposed to mutually react on each other, have been found sufficient to overcome all the difficulties surrounding optical phenomena. One of the most important difficulties that the elastic solid theories cannot get over is the want of indication of a longitudinal wave which the theories demand, unless the ether be incompressible. Also the phenomena of reflection can be explained most easily by assuming that the vibrations are perpendicular to the plane of polarisation, while the phenomenon of double refraction can be most easily explained by assuming that the vibrations are in that plane. The phenomena of double refraction also demand a most elaborate connection between the coefficients of elasticity of the ether. On the other hand, as Maxwell says in his splendid article on "Ether," in the ninth edition of the "Encyclopædia Brittannica": "The electromagnetic theory of light satisfies all these requirements by the single hypothesis that the electrical displacement is perpendicular to the plane of polarisation. No normal displacement can exist, and in doubly refracting crystals the specific inductive capacity for each principal axis is assumed to be equal to the square of the index of refraction of a ray perpendicular to that axis."

That the electromagnetic theory is a completely satisfactory theory is unfortunately not yet established, but it is the theory which has fewest assumptions and explains most. Indeed, all the phenomena that can be explained by the other theories can be as well explained by the electromagnetic theory, and, besides these, a number of objections to the other theories are avoided. The peculiar disadvantage of the theory, however, is the difficulty of realising clearly what electrical polarisation—or, as Maxwell calls it, electric displacement—is. Before mentioning what has been done in this direction, I shall take up that part of the theory which was first developed.

In 1865 Maxwell gave his theory, the substance of which is contained in the second volume of his "Electricity and Magnetism," Chapter 20. In Chapter 9, on the "General Equations of the Electromagnetic Field," he brings into prominence what he calls "displacement" currents. In a medium capable of conducting a current, he supposes the whole current to be represented by the sum of the ordinary conduction current and the displacement current. The explanation of the latter will be best made in Maxwell's own words: "When the E.M.F. acts on a conducting medium it produces a current through it, but if the medium is a non-conductor, or a dielectric, the current cannot {continue to} (the words in brackets are Prof. J. J. Thomson's) flow through the medium, but the electricity is displaced within the medium in the direction of the electromotive intensity." The rate of this displacement is, therefore, the current.

As, in Chapter 20, his chief object is to obtain the equations for the electromagnetic disturbance in media which are capable of transmitting light, he first takes the case of a perfect non-conductor, as his theory indicates that a good conductor of electricity is opaque, and a good insulator transparent to light-vibrations. He then gets three differential equations for the determination of the E.M.F.'s F, G, H along the three axes of co-ordinates,

$$K\mu\frac{d^2 F}{d t^2} = \frac{d^2 F}{d x^2} + \frac{d^2 F}{d y^2} + \frac{d^2 F}{d z^2},$$

and similar equations for G and H, where K = specific inductive capacity, and μ = the magnetic permeability of the substance. Now, these equations are precisely similar to those for irrotational motion in a homogeneous aeolotropic elastic solid. The equations for this case are—

$$\rho_1\frac{d^2 u}{d t^2} = M\left(\frac{d^2 u}{d x^2} + \frac{d^2 u}{d y^2} + \frac{d^2 u}{d z^2}\right)$$

etc., etc., for v and w, the displacements along the other two axes, where ρ_1 is the density and M the elasticity of the solid.

We see, therefore, that $\frac{M}{\rho_1}$ in the elastic solid corresponds to $\frac{1}{K\mu}$ in the electric problem. $\frac{M}{\rho_1}$ is the length-modulus, so $\frac{1}{K\mu}$ is proportional to the length-modulus of the ether. As a matter of fact, we have for the total displacement or strain across any closed surface $D = \frac{Q}{4\pi r^2}$, and for the force producing this displacement, $F = \frac{Q}{K r^2}$, where Q is the quantity of electricity on the surface. We have thus, from analogy,

$$\text{Electric elasticity} = \frac{\text{stress}}{\text{strain}} = \frac{F}{D} = \frac{\frac{Q}{K r^2}}{\frac{Q}{4\pi r^2}} = \frac{4\pi}{K}$$

We see, then, that $\frac{4\pi}{K}$ corresponds to M, and $\frac{1}{K\mu}$ corresponds to $\frac{M}{\rho_1}$, and we have, therefore, that $4\pi\mu$ is the electromagnetic density of the medium, and $\frac{4\pi}{K}$ the electric elasticity. So far, then, the electromagnetic disturbances have been treated in exactly the same way as if electromotive force were proportional to displacements in a homogeneous elastic solid, whose density is $4\pi\mu$, and elasticity $\frac{4\pi}{K}$. Now, μ and K both vary with the medium, and therefore the electromagnetic theory so far agrees with a simple elastic solid theory, in which not only the elasticity, as Fresnel assumed, and not only the density, as MacCullagh and Neumann assumed, but both quantities vary. As regards dielectrics, therefore, we might so far consider, on the electromagnetic theory, that electrical and light disturbances in them are simply displacements in the ether of the dielectric, this ether having its elasticity equal to $\frac{4\pi}{K}$ and its density equal to $4\pi\mu$. This would then give for the velocity of propagation of both disturbances $\frac{1}{\sqrt{K\mu}}$. This gives us at once the first test of the theory, since we know that light of all wavelengths travels with the same velocity in vacuum or air, for which K is unity and $\mu = \frac{1}{v^2}$ on the electrostatic system of measurement, and $K = \frac{1}{v^2}$, $\mu = 1$ on the electromagnetic system, v being the number of electrostatic units of electricity in an electromagnetic unit. It is therefore necessary that v should be rigorously equal to the velocity of light in vacuum. We find a very close though not perfect agreement, the velocity of light as last measured by Newcomb being $2{\cdot}99766 \times 10^{10}$ centimetres per second, while the value for v found by J. J. Thomson two years ago was $2{\cdot}9955 \times 10^{10}$. This small difference is quite within the range of experimental error.

(To be continued.)

THE COST OF ELECTRIC SUPPLY.*

BY DR. JOHN HOPKINSON, F.R.S.

The interests of an engineer are many sided. If he is to successfully use the forces of Nature for the service of man he must understand how those forces work; he must, in fact, be scientific. It may be that his ideas are arranged differently from the ideas of those who study science for its own sake, and without regard to practical applications, but if he is to succeed they must be so arranged that he can deduce from knowledge already acquired, knowledge which is applicable to new cases which have not as yet come under his observation. The engineer who can only do that which he has seen done before may be a practical man, but he will always belong to a lower grade of his profession. The scientific engineer is one who by his knowledge of Nature is able to deal with new engineering problems and provide useful solutions of those problems. But a practical man must be something more than a man of science, or rather he must look at matters from a different point of view. He cannot choose some feature of a problem, concentrate all his attention upon that, and leave other matters out of consideration, which is the process by which most scientific advance has been made; but he must always deal with the whole matter before him and leave no relevant question out. But an engineer may be scientific, inasmuch as he has knowledge of Nature and the power of applying that knowledge in new cases; he may be practical in the sense that the means he devises to attain his ends may be complete at all points, and not break down from trifling defects, and yet may find that there are other subjects which he has to consider. Our complete engineer must give his attention to commercial matters as well; he must know if, when he has devised the means to attain the ends in view, those ends when attained will result in profit. He must recognise the conditions which render an undertaking economical to work, and which secure that it shall bring in a large return. When it has been my lot to address engineers I have usually directed attention to some scientific point which I thought would be of interest to them. This evening I should like to go to the other extreme and deal with a purely commercial question, with a matter into which no science enters, and which relates entirely to pounds, shillings, and pence.

You are all of you familiar with the fact that the expenses of an undertaking may be broadly divided into two classes. On the one hand there are expenses which are quite independent of the extent to which the undertaking is used, and on the other, expenses which are absent unless the undertaking is used and which increase in proportion to the use. For example, the charges for interest on the construction of a bridge are the same whether that bridge is used much or little or at all, and the cost of maintaining the bridge is also practically independent of its user. The same is true in a large measure of a harbour or a dock. Such undertakings lie at one extreme of the scale. It is less easy to find good examples at the present day of the other extreme, as nearly all undertakings with which engineers have to deal require the employment of some capital, and there will be a fixed charge for the use of that capital, and for maintaining against the assaults of time the things in which the capital is embodied. But we can readily see, for example, in the case of a cotton mill, that if, on the one hand, there are expenses for interest and dilapidation which are independent of the amount of yarn actually manufactured in a given factory, there are other expenses for material and labour, and even for actual wear of machinery, which will be very nearly proportional to the output. Undertakings vary enormously in the proportion of these two classes of expenses, in some the expense is quite independent of the extent of the user, in others it is for the greater part proportional to the user.

But undertakings differ from each other in another respect. In some cases the service which the undertaking is designed to render can be performed at a time selected by the undertakers; in others, at a time selected by those to whom the service is rendered. In the case of most manufactures, it matters not if the thing made is made to-day or to-morrow, in the morning or the evening, for it will not be used for a month hence, perhaps. The thing can in fact, be extensively stored and kept till it is wanted. Other services must be rendered at the moment the person served desires. For example, the Metropolitan District Railway must be prepared to bring in its thousands of passengers to the City at the beginning of the day and to take them back in the evening, and for the rest of the day it must be content to be comparatively idle. In this case the service cannot be stored. The line must be of a carrying capacity equal to the greatest demand, and if this be great for a very short time the total return for the day must be small in comparison with the expense of rendering the service. In such a case it would not be inappropriate to charge more for carrying a person in the busy time than in the slack time, for it really costs more to carry him.

Let us see how these considerations apply to the supply of electricity for lighting. Electrical engineers now realise that they have to provide the same plant and no more to give a steady supply day and night as to give a supply for one hour out of the 24. They also now realise that if they are to be ready to give a supply at any moment, they must burn much coal and pay much wages for however short a time the supply is actually taken. Indeed, the term "load factor" proposed by Mr. Crompton is as constantly in the mouths of those who are interested in the supply of electricity, as volt or ampere or horse-power. The importance of the time during which a supply of electricity is used was so strongly impressed on my mind years ago, that in 1883 I had introduced into the provisional orders with which I had to do a special method of charge intended to

* Presidential address delivered before the Junior Engineering Society, Nov. 4, 1892.

secure some approach to proportionality of charge to cost of supply. Unfortunately, the orders of that day all came to nought.

A supply of electricity must be delivered at the very moment when the consumer chooses to use it, and as long as and no longer than he pleases to use it; it cannot be very readily or cheaply stored, and much of the cost of production is the fixed charge for plant and conductors. Furthermore, the provisional orders require that the supply shall be available at all hours; hence coal must be consumed and workmen must attend, though but few consumers are drawing a supply. The service of supplying electricity has from an economic point of view a great deal of similarity to the service of providing a breakwater for a harbour. A great deal of the expense is independent of the number of hours in the day during which the supply is used. To put it in another way, the cost of supplying electricity for 1,000 lamps for 10 hours is very much less than 10 times the cost of supplying the same 1,000 lamps for one hour, particularly if it is incumbent on the undertaker to be ready with a supply at any moment that it is required.

The actual importance of considerations of this kind can only be realised by examining figures. The figures may as well be estimated figures, because the circumstances vary from one neighbourhood to another. No criticism of the details of the figures will affect the general character of the conclusion. Let us then imagine a station capable of supplying 40,000 16-c.p. lamps at one time, with mains and spare machinery enough to ensure that the supply shall not fail, and let us see what the charge for running such a station will be: firstly, on the hypothesis that it is always to be ready to supply the 40,000 lights at half-an-hour's notice day or night but that the lights are hardly ever actually required; secondly, on the hypothesis that the 40,000 lights are steadily and continuously supplied day and night. These are the two extreme cases possible. In the former the load factor is nil; in the latter it is 100 per cent. If the charge is by meter at 8d. per unit in the former case, the revenue will be nil; in the latter it will be £730,000 a year.

We are going to divide the cost of supplying electricity into two parts: a part which is independent of the hours the supply is used, and a part which is directly proportional thereto, and we are going to estimate the amount of each element. It is for the purpose of ascertaining these elements that we consider two quite hypothetical cases, cases which can themselves never actually occur.

We must first have an idea of the capital outlay required. To provide the maximum of 40,000 lamps we need to deliver 2,500 units per hour, and we may estimate the capital outlay as follows:

Land	£25,000
Buildings	15,000
Boilers and pipes	14,000
Engines	24,000
Dynamos	15,000
Switchboard and instruments	2,000
Feeders and mains	50,000
	£145,000

Let us deal with the annual charge for each item of capital separately on the two hypotheses. The charge for land and for buildings, including repairs, is clearly the same in the two cases—say, at 4 per cent., £1,000 for the land, and at 10 per cent., £1,500 for the buildings. The boilers, engines, and dynamos will have a charge for interest, and a charge for writing off—or amortisation as the French call it—that is, for writing off the value of the plant before the time at which it becomes antiquated—exactly the same in the two cases. The boilers, too, will require exactly the same repairs whether they are merely keeping steam or whether they are generating steam continuously; but the machinery will certainly require more for repairs and renewals if it is all running than if a part only is running without load and the rest is standing ready for a load if required. I take 4 per cent. as the charge for interest, 3 per cent. for amortisation, 8 per cent. for repairs and maintenance. Of the repairs of engines and dynamos I assume that 2 per cent. will be applicable if the plant runs light, the remaining 6 per cent. if it is fully and continuously loaded. The expenses connected with conductors and switchboard, etc., will be exactly the same whether the current is passing or not; these I take at 15 per cent. The rates I put down at £500 a year. The account, then, for the fixed charges already enumerated would stand as follows:

	Running light.	Fully loaded.
Land	£1,000	£1,000
Buildings	1,500	1,500
Rates	500	500
Boilers	2,100	2,100
Switchboard and conductors	7,800	7,800
Engines	2,160	3,600
Dynamos	1,350	2,250
	£16,410	£18,750

We now come to a most important item in the account, the coal. There is no doubt that with uniform and continuous load a unit of electric energy—1⅓ h.p. for one hour—can be produced for less than 3lb. of coal; it is also pretty much admitted that with a load factor of about 12 per cent., but continuous maintenance of pressure, the consumption of coal in good practice is something like 7lb. That is to say, to keep the boilers warm, turn round the machinery for 24 hours, and deliver full current for 24 hours, will require 72lb. of coal per kilowatt; whereas, to keep the boilers warm, turn round the machinery and deliver current for three hours, will require 21lb. of coal. The boilers being kept warm, it will take 51lb. of coal to generate steam enough to give a unit per hour for 21 hours; 58lb. to give a unit per hour for 24 hours; subtracting this from 72lb., the amount required both to generate steam and keep the boiler warm, we may infer that to keep the boiler warm and merely turn the machinery in readiness to meet a demand will take about 14lb. of coal per day for every unit per hour the plant is capable of producing. In 1889, for the Society of Arts, tests were made of a Paxman compound engine, from which it appears that a boiler which when fully loaded consumed 40lb. of coal per hour, required 4lb. per hour to keep steam up to normal pressure when the engine was standing—that is, 10 per cent. of the coal used was used to maintain the steam pressure. Remembering that in addition we keep some of our machinery moving, this may be said to confirm the figures adopted. Thus, if the plant runs light all the year round, 12,775,000lb., or let us say 6,000 tons, of coal will be consumed. If the plant runs fully loaded 65,700,000lb., or let us say 30,000 tons, will be consumed. If we suppose the coal to be best smokeless it might cost 20s. per ton. Next we have water, oil, and petty stores—say, £600 and £3,000 in the two cases. Wages will be a little less if we run light than if we run fully loaded, and of course will largely depend on local circumstances; let us say £5,000 and £7,500 in the two cases. This gives us substantially all the expenses which have to be met, and our account will then stand thus:

	Running light.	Fully loaded.
Fixed charges	£16,410	£18,750
Coal	6,000	30,000
Stores	600	3,000
Wages	5,000	7,500
	£28,010	£59,250

Thus the cost of merely being ready to supply 2,500 units per hour at any moment throughout the year will be £28,010, and the cost of actually supplying 2,500 units per hour for every minute in the year will be £59,250. The undertaker therefore who incurs the liability to supply ought to receive £11 per annum per unit per hour from those on whose behalf he incurs the liability, and if he receives the £11 he need not charge more than ⅓d. per unit for what he actually supplies, to cover his expenses. That these figures are fair approximations can be seen as follows: According to this calculation the cost of supplying 2,500 units for one hour per day is £28,010 + 2,500 × 365 × ⅓d. = £29,277, and the charge for the service at 8d. a unit would be £30,410; it is doubtful if such a supply would pay. On the other hand, an indicated horse-power on such a scale could certainly be supplied continuously for from £12 to £14 per annum, and, according to this calculation, an electrical horse-power will cost just £18 per annum. No account is taken of expenses peculiar to companies, such as

directors' fees and the cost of forming the company. It will also be noted that it is assumed that accumulators are not used.

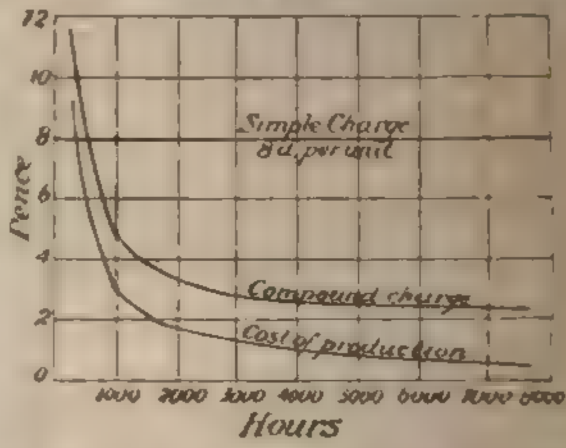
The charge for a service rendered should bear some relation to the cost of rendering it. If it is a matter of open competition the matter will settle itself, for no one will be long be able to supply some customers at a loss, and recoup himself by exorbitant profits from others. If the matter be a case more or less of monopoly, the adjustment is less certain, thus the Post Office charges ½d postage for a printed circular and 1d for a written letter, the two costing the Post Office exactly the same. What a boon to the public it would be if the Post Office would charge more for printed trade circulars, which in nine cases out of ten are a nuisance to those who receive them. The supply of electricity is not quite a monopoly; companies compete with each other, and there is always the competition with other methods of illumination, such as gas and paraffin. It is clearly to the advantage of the undertaker to secure all those customers whom it pays best to supply, and as far as may be to compel those who are unremunerative to adopt these other methods. The ideal method of charge, then, is a fixed charge per quarter proportioned to the greatest rate of supply the consumer will ever take, and a charge by meter for the actual consumption. Such a method I urged in 1883, and obtained the introduction into certain provisional orders of a clause sanctioning "a charge which is calculated partly by the quantity of energy contained in the supply and partly by a yearly or other rental depending upon the maximum strength of the current required to be supplied." In fixing the rates of fixed charge it must not be forgotten that it is improbable that all consumers will demand the maximum supply at the same moment, and consequently the fixed charge named might be reduced or some profit be obtained from it. There is no object in reducing the cost of electricity for lighting in the case of any customer much below the cost of equivalent lighting by gas, unless there are competitors in the field willing to do it, hence the current charge proportioned to the power supplied may safely be increased. In certain recent cases in which I am acting as engineer, the Board of Trade have sanctioned on my application, "for each unit per hour in the maximum power demanded, a charge not exceeding £3 per quarter, and in addition for each unit supplied a charge not exceeding twopence." It is sometimes said, as an objection to this method of charge, the public will object to pay a fixed charge whether they make use of their lights or not, and that, in fact, they will not pay it. The best answer that can be made is to give everyone the choice of being charged the maximum simple rate provided by the order, or by the compound rate as they prefer. What is wanted is not so much an increased charge for those consumers whose lights are used for a short time, as such a special reduced charge for those whose lights are used long as will induce them to use the supply.

It is instructive to compare the cost to different classes of consumers of electricity and gas for lighting with 16-candle gas. Flat flame burners must be large and of first-rate quality to give more than two candles per cubic foot of gas per hour; the large majority of burners give much less than this even at their best, and as a rule the pressure of the gas is not regulated and much gas is wasted as far as the production of light is concerned. Incandescent lamps give about one quarter of a candle per watt; hence a B.T.U. is equivalent to 125 cubic feet of gas. Thus we readily arrive at the following comparative table, the charge being at the rates recently sanctioned by the Board of Trade:

Hours of use per annum.	Load factor.	Price of gas at which cost of lighting by electricity and 16-candle gas are equal
480	5.5	5s. 4d
960	10.9	3s. 4d
1,440	16.4	2s. 9d.
1,920	21.9	2s. 4d.
2,880	32.9	2s. 0d
3,840	43.8	1s. 10d
7,680	87.6	1s. 7d.

In the accompanying curves are shown the cost of production, and the charge per unit at the compound and simple rate. The ordinates represent pence and the abscissæ the number of hours per annum the supply is used.

It is obvious that those whose user is long will find the electric light economical to themselves and that it will be profitable to the undertaker. With a cheap light which is free from the products of combustion there will be extensions for the hours of use. Shops may find it worth while to continue the light after closing, as an advertisement.



We have so far assumed that the supply of electricity is carried on without the aid of accumulators. Let us first compare the cost of an electric accumulator with the cost of a gasholder containing the same possibility of producing light. A gasholder is at present being put up in Manchester to hold 7,000,000 cubic feet of gas, and is to cost complete with its tank £60,000. With 16-candle gas 7,000,000 cubic feet are equivalent to 56,000 B.T.U. Accumulators capable of storing a 10-hours' supply, cost about £50 per unit. The equivalent accumulator will therefore cost about £280,000. But this is not all; the gasholder is comparatively permanent; the accumulators require frequent renewals and repairs; the gasholder gives back all the energy put into it; the accumulators waste at least 20 per cent.; the gasholder may be emptied as fast as you please, the accumulators, not faster than a certain rate without diminishing their capacity. Taking all into consideration, the cost of storing energy by the use of accumulators, and storing it in a gasholder, are quantities of a different order of magnitude. If no gasholders were used, and all the gas had to be made just as it was wanted, its cost for lighting would be several fold what it now is, even if gas producers could be found capable of instantly varying the supply as the demand varies. The gas producing plant would have to be enormously increased, so would the size of the mains, and so would the wages of labour. If electric power could be stored as cheaply as gas, there would soon be little hope that the gas companies would maintain their dividends.

Let us see from a financial point of view whether accumulators can be used economically for storing up electrical power continuously produced during the 24 hours, and used rapidly for a short time.

Assume that the whole of the plant with the accumulators is capable of supplying 40,000 lights for 10 hours continuously, and that during that time half the power is supplied from the accumulators. Ten hours in the 24 hours is not an unreasonable allowance, for we have melancholy experience in London of continuous fog for days, and this would tax the plant we are considering to the utmost. We are to be ready then at any time on short notice to supply 40,000 lights, and to continue to supply them for 10 hours. Compare the cost, firstly of maintaining this state of readiness with the accumulators and with a plant without accumulators. We shall require a battery capable of giving 1,250 units for 10 hours; such a battery costs not less than £50 per unit, or in all £62,500. To maintain it, will cost from 10 to 15 per cent. on the cost; there will also be interest on the outlay and amortisation—say, in all 20 per cent., or £12,500 a year. If we assume that the batteries are distributed at the various points of the system of conductors, we may also assume that the charges for land and buildings will be much the same as for the plant without accumulators. The

boilers, engines, and dynamos will be just one-half. The switchboard and instruments will be much the same. But the conductors will be reduced, smaller or shorter feeders being necessary, probably £40,000 will go as far with accumulators as £50,000 without. The coal bill may be dispensed with entirely, as we may assume that steam could always be got up during the time in which the demand increased from nothing to one-half of the maximum, and that therefore all the coal burned can be assumed to be burned for producing current. That is to say, we assume the quantity of coal burned is proportional to the quantity of electric energy, and that therefore when no electricity is actually used no coal will be burned. The wages may be reduced, for we have only to be ready to run half the plant, and a small wage will suffice for attendance on the accumulators. The wages of linesmen and the like will remain the same. Assume the total wages to be £3,500 instead of £5,000. The account will then stand thus:

Land	£1,000
Buildings	1,500
Rates	500
Accumulators	12,500
Boilers	1,050
Engines	1,080
Dynamos	675
Switchboard	300
Conductors	6,000
Wages	3,500
	£28,105

practically the same result as we obtained before.

Now, consider another hypothetical case, which, of course, can never occur in practice. We are to supply 40,000 lamps for 10 hours every day with the plant just described, charging the accumulators during 12½ of the 14 hours during which the light is not required, 12½ hours charging giving 10 hours discharge of the same energy. The coal would cost the half of £30,000 if the machinery had to run the whole of the 24 hours. It has to run 22½ hours, but the boilers have to be kept warm the whole time, hence the coal will cost the half of £6,000 for keeping the boilers warm, and $\frac{22\frac{1}{2}}{24}$ of the half of £24,000 for generating steam. The wages may fairly be taken as £4,750, and the account will stand:

Land	£1,000
Buildings	1,500
Rates	500
Accumulators	12,500
Boilers	1,050
Engines	1,800
Dynamos	1,125
Switchboard	300
Conductors	6,000
Wages	4,750
Coal	14,250
Stores	1,425
	£46,200

The cost of supply for the same 10 hours without accumulators would be as follows:

Land	£1,000
Buildings	1,500
Rates	500
Boilers	2,100
Switchboard and conductors	7,800
Engines	2,760
Dynamos	1,725
Coal	16,000
Stores	1,600
Wages	6,000
	£40,985

a cost of about 11 per cent. less than where accumulators are used.

Putting it another way, the cost of being ready to supply and to continue to supply is about the same whether accumulators are used or not; the additional cost of actually supplying current is about 40 per cent. more where accumulators are used than where they are not used. It may be safely inferred that the use of accumulators does not seriously alter the conclusions I have drawn as to the proper method of charging consumers for a supply of electricity.

The question of whether the great cost of a supply for short hours can be removed by the use of accumulators may be looked at in another way. Will it pay a consumer to put in his own accumulators and charge them from the station supply? We may reasonably suppose the undertaker will remit the fixed charge in consideration of the consumer only taking his current at slack times. His accumulators, if they are to be of capacity to maintain his supply through a foggy day, will cost him £50 per unit per hour (or per kilowatt), and the annual charge in respect of them will be £10 per year, to which, if we add a rent for the space the battery occupies, gives us a charge not differing materially from the fixed charge made, or suitable to be made, by the undertaker. But in order to obtain 2d. worth of electricity he must purchase 2½d. worth for charging his battery.

A word or two more about the use of accumulators. These have certainly improved, and they will continue to improve. They will become more durable and more economical of power in working, and their first cost will become less. An inspection of my tables of cost shows that a very little improvement would render them valuable even in very large stations for the mere purpose of diminishing the machinery required, by storing the energy developed at slack times to be used in busy times. The certainty of improvements in accumulators, and the possibility that the improvement may be considerable, is a strong argument for the use of the direct current wherever it is not precluded by the distance of transmission being too great. It will be noted that I have assumed a very large station. Accumulators have another use which greatly increases their advantage in smaller stations. There are many hours in the 24 when it is absolutely certain that the demand will be small. If accumulators are used the attendance of the staff may be dispensed with during those hours, and a considerable sum in wages will be saved. The proportion of wages to the whole of the charges is much greater in small stations than in large. In most small stations giving continuous supply accumulators ought to be used, notwithstanding their expenses and defects, and I believe the day is not far distant when they ought to be used in connection with most large stations also.

If, instead of a continuous current, an alternating current with transformers is used, the modification in the account will be that the cost of conductors will be diminished, but the cost of transformers will have to be added. If the distances are small, the increased cost of transformers will exceed the saving in the conductors; if the distances are considerable, the cost of transformers will be less than the saving of conductors. In both cases the general character of the result will be the same as before, the cost of being prepared to give a supply will be considerable, and the cost of actually giving the supply will be much smaller than is generally supposed. Indeed, with the alternating current this peculiarity will be even more marked, for the machinery has not only to be kept in motion, however small the consumption may be, but a certain current must be maintained in every transformer. With the best transformers this current may only have an energy 1½ per cent. of the energy of the current when the transformer is fully loaded. This would increase the coal bill in the case considered by about £500 per year whether the supply was used or not.

It is possible, indeed probable, that some of my assumed figures may be shown to be too high or too low for the generality of cases. It is of no moment; let each one take any figures he pleases within reason; let him assume that the supply of electricity is made by any system he pleases; he will arrive at a result broadly similar to mine. To be ready to supply a customer with electricity at any moment he wants it will cost those giving the supply not much less than £11 per annum for every kilowatt—that is, for every unit per hour—which the customer can take, if he wishes, and afterwards to actually give the supply, will not cost very much more than ½d. per unit. This is the point I have been labouring to impress, for I take it is essential to the commercial success of electric supply. It is hopeless for electricity to compete with gas in this country all along the line, if price is the only consideration. But with selected customers, electricity is cheaper than gas. Surely it is the interest of those who supply electricity to secure such customers by charging them a rate having some sort of relation to the cost of supplying them.

THE

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CONTENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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COMPANIES' FINANCIAL STATISTICS.

In another column we give some financial statistics, compiled by Messrs. Faithful Begg and Co., relating to electrical companies. This compilation covers but a small field, and leaves out a large number of companies, but from many points of view it is interesting. It may, however, be taken as including most of the companies whose shares have a market, and are bought and sold on the Stock Exchange. Comparisons are odious, yet we are fain to point out that from October, 1878, when the "British Electric" was promoted, to the end of 1882, some fifty-six companies were floated with a total capital of £20,910,500. Of course the whole of this capital was never paid up, but the greater half was, and the major portion of the capital so paid up was entirely lost. During that palmy time for promoters, investors lost their heads, and their money. Of the above-mentioned fifty-six companies no less than twenty-four saw the light in one month—viz., May, 1882; in fact, all but five saw the light in that year. Now we are drawing towards the close of 1892, and this list of Messrs. Begg and Co. comes to remind us of successes and of failures. Dividing the companies into two classes, as in the tabular statement, the supply companies mentioned have a total capital of close on five and a quarter millions, of which just over two millions eight hundred thousand pounds are paid up. The total profit during the year, so far as the figures are available, amounted to a little over twenty-five thousand pounds, or not quite one per cent. on the capital paid up. The manufacturing companies show a much better return than this, though we may here call attention to one remarkable omission on the part of the compiler. Where is "Woodhouse and Rawson"? It is neither among the supply nor the manufacturing list. However, the list as given shows a total capital of close on four and three-quarter millions, and a called-up capital of close on two million seven hundred thousand. The profit during the year reached the satisfactory figure of two hundred and eleven thousand, or nearly eight per cent. upon the paid-up capital.

At the present moment, then, there is a broad distinction between the earning powers of the supply and the earning powers of manufacturing companies, and the question naturally arises, Is this a detriment to the supply companies? In our opinion it is not, and our reason for touching upon these financial statistics is to explain why it is not; otherwise investors might feel inclined to button up their pockets, and great damage might accrue to the industry by a mere circulation of figures without the facts of the case being clearly put. It must always be remembered that supply companies have to legislate for the future rather than for the present. A large portion of their capital expenditure, therefore, is understood to be for the moment unproductive, but differing from the manufacturing concern their income should be a rapidly-increasing one, and not till they have full load upon their mains and stations will the capital expended bring in its full return. In the manufacturing concern the expenditure is more or less proportional

to the receipts, and as the business increases the expenditure proportionally increases, but the opposite is the case with the supply companies—the initial expenditure being out of all proportion to the returns. We should imagine, also, that the profits from the manufacturing concerns have even now about reached their limits, and that the shareholders do not expect much, if any, more. The difference may be put in another way. With manufacturing concerns the maximum return upon capital is quickly reached; with the supply companies the maximum comes slowly, but when obtained is more likely to be constant. It is not liable to competition derangement. Manufacturers compete one against the other for orders, and the tendency is always to knock down prices in order to get work. Little or nothing of the kind happens with supply companies, and as lamps are gradually added the income increases more rapidly than the expenditure. These views should be made as widely known as possible when the public is deluged with statistics of the kind we have referred to. We will go so far as to venture to assert that even the London Electric, with its huge capital and its shares at present merely of nominal value, may turn out a lucrative investment to those who come in now, providing the management is conducted properly. Only a portion of its capital is irretrievably lost—that which has been spent upon engines and dynamos which will never be erected, and which if erected would lead to loss instead of profit. If the company goes on carefully it may add, from revenue, unit to unit, till the full capacity of the station is reached with workable units rather than with exceptional units. The statistics, so far as we are concerned, may now be studied by every reader with considerable advantage.

OBITUARY.

THE LATE DUKE OF MARLBOROUGH.

We regret to have to record that on Wednesday the Duke of Marlborough was found dead in his bed. It seems that his valet, as was usual, went into his room with some cocoa, and at first saw nothing amiss. Subsequently on opening the blinds he found the Duke was dead, and immediately gave the alarm. According to all information death seems to have been caused by syncope. The late Duke of Marlborough was the eighth, and was born in 1844. Of late years he has been closely allied to the electrical industry. He was chairman of the New Telephone Company, the Brush Electrical Engineering Company, and the Electric and General Investment Company, and a director of the City of London Electric Lighting Company. It will be remembered that he took a very active part in the formation of the New Telephone Company and the amalgamation with the National; in fact, during the last two or three years, he has been one of the most active spirits in the development of electrical enterprises connected with lighting and telephonic matters.

THE LATE MR. EDWARD GRAVES.

It is our painful duty to record the death of Mr. Edward Graves, engineer-in-chief to the British Post Office Telegraphs, which occurred in the early morning of November 9th, 1892, caused by diabetes, from which he had suffered for some time.

Mr. E. Graves was born in February, 1834, and after a brief connection with the North-Eastern Railway Company, he first became connected with telegraphy in 1852, when he entered the service of the Electric and International Telegraph Company at York, under Mr. de Chesnel, whom he acted for during a prolonged illness, and in 1856 succeeded as superintendent and district engineer for the East Coast of England and Scotland, extending from London to Aberdeen. As the company's system developed the district was divided, and at the transfer of the telegraphs to the State in 1870, Mr. Graves was divisional engineer for the Northern district, with headquarters at York. Possessed of great administrative ability and financial acumen his interests were employed in defending the interests of the Post Office during the arbitrations, 1874-8, between the department and the various railway companies who were entitled to compensation under the Telegraphs Act of 1868, and the success of his efforts was mentioned by Sir Richard Bagallay, then Attorney-General, and other eminent counsel connected with the cases, and received official recognition by the department. In 1878, Mr. R. S. Culley, the engineer-in-chief, retired from active service, and Mr. Graves was appointed to succeed him in that office, and immediately reorganised the engineering staff. He was a delegate to the Paris Electrical Conference in 1881, and received the cross of an officer of the Legion of Honour from the French Government; he was a member of the Channel Tunnel Defence Committee, in 1882; of the Electrical Standard Units Committee; and of the Royal Commission on Electrical Communications with Lighthouses and Lightships, whose report is expected shortly. Mr. Graves was one of the early members of the now Institution of Electrical Engineers, of which he was for many years honorary treasurer, and in 1888 was its president.

ELECTRIC LIGHTING OF SMITHFIELD MARKETS.

On Friday evening last week the then Lady Mayoress, accompanied by the then Lord Mayor and a distinguished party of City magnates, performed the ceremony of switching on the electric light to these markets. In our last issue we described the temporary installation and the proposed permanent installation, but we venture to predict that the permanent installation will eventually be even larger than we described. The inaugural ceremony took place in the poultry and provision section of the Central Markets, which completes the series of markets erected by the Corporation. The Lord Mayor and the Lady Mayoress were received on their arrival by Mr. H. W. Greenwood (chairman of the Grand Markets Committee) and the members thereof, and were conducted to a platform, the Lady Mayoress being presented by Mrs. Sax with a handsome bouquet. Mr. Greenwood addressed his lordship, and invited him to inaugurate the important addition to the markets which had just been completed by Messrs Sax and Co., the contractors, whom he introduced. The markets, he said, had now been completed, at a total expense to the Corporation of £3,300,000, and an evidence of the ever-continuing importance of the buildings was to be found in the fact that the weight of goods delivered in the present year had been 8,332 tons in excess of that for the corresponding period of last year. The length of the wire required to complete the installation was about 40 miles, while the number of incandescent lamps to be fitted on the premises of tenants reached 12,000, of from 15 c.p. to 50 c.p. each. The main avenues would be lighted with 100 lamps of 50 c.p. each. The plant consisted of six dynamos with an output of 200 units each, worked by four engines of 200 h.p., two additional engines being held in reserve to provide against any chance of failure. The whole of the instruments used in the installation had been manufactured by Messrs. Sax, at their own factory, and the entire work formed the largest private incandescent scheme yet undertaken. The Lady Mayoress, upon the invitation of Mrs. Charles Sax, then removed a jewelled dagger placed in a piece of mechanism on the platform, and the electric light at once flooded the markets, loud cheers greeting its appearance. Mrs. Sax presented her ladyship with the dagger, which was much admired. A vote of thanks to the Lord Mayor and the Lady Mayoress, moved by Mr. George Taylor, chairman of the Central Markets Committee, concluded the proceedings.

Subsequently about 100 guests met, at the invitation of

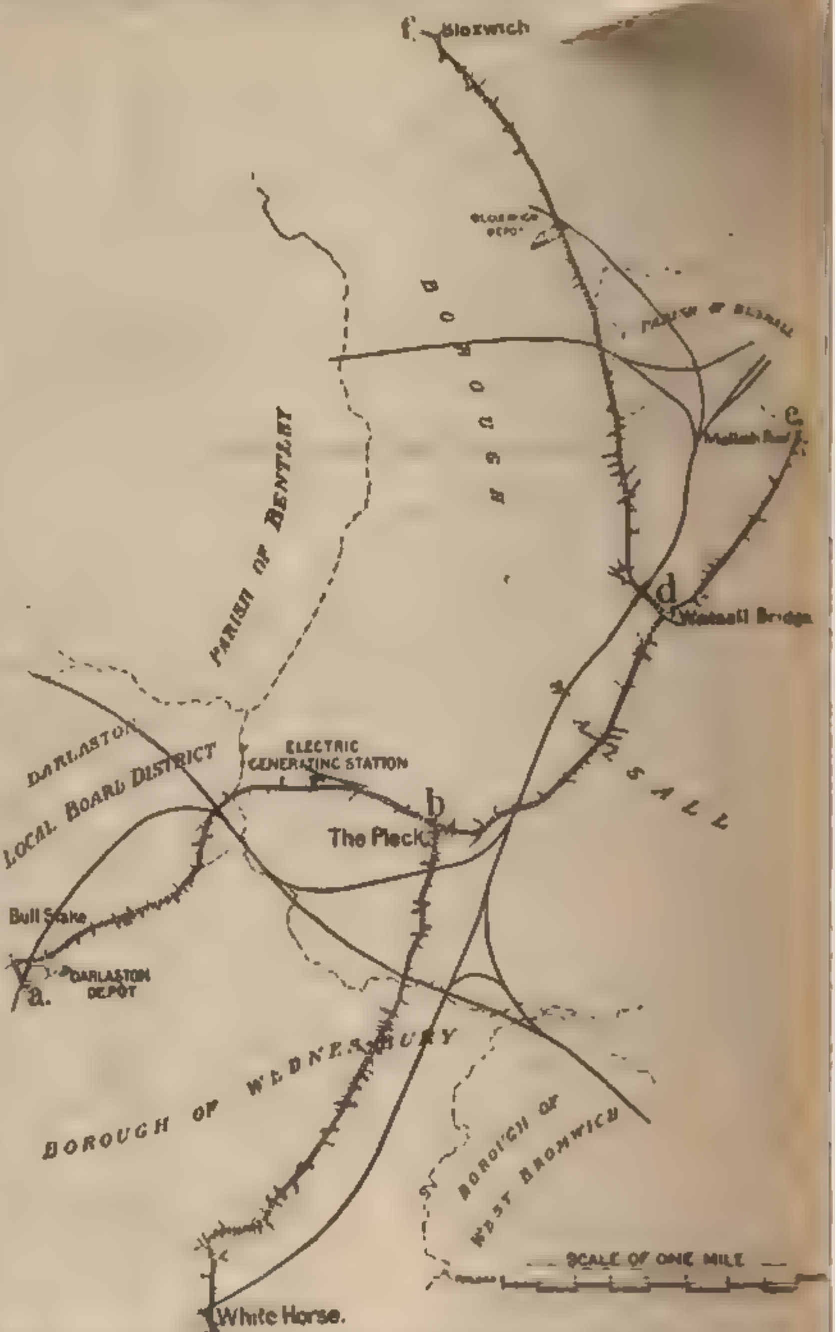
Messrs Sax, the contractors, to dine at The Dr Butler's Head, Mason's yard. The dinner was all that could be desired, and it was perfectly evident from the various speeches that a keen desire exists in the City for the success of electric lighting.

When the permanent installation is complete we hope to have more to say on the subject. Meanwhile the wiring and other arrangements are being carried out with great care and energy, so that there is every prospect of a great success.

SOUTH STAFFORDSHIRE TRAMWAYS.

It is rumoured that the Board of Trade inspection of this new system of electric tramways is to be held within the next few days, and that soon after the public opening will be arranged. Of course, the technical arrangements so admirably carried out by Mr. A. Dickenson cannot yet be described, but we may venture to give a plan of the district through which the lines run, with the gradients that have to be surmounted. Walsall, the centre of the system, is in ancient records written Whaleshall and Walshale, and is supposed to have derived its name from its vicinity to an extensive forest wherein the Druids worshipped, and subsequently the Saxons, the latter erecting a temple to Woden—hence Wednesbury at no great distance.

Pleasantly situated upon the summit and sides of a limestone rock, watered by a small stream called by Erdeswick "Walsal Water," which falls into the Tame, Walsall is in the midst of a manufacturing and a mining district, ruled by men of energy and business capacity always seeking to improve means of communication and assist the workers of the district. It is not to be wondered, then, that this district adopted electric traction, and the system found favour which had succeeded so well in America — viz., the overhead system. More we cannot say at present, but await with interest the forthcoming inspection.



MAP OF THE SOUTH STAFFORDSHIRE TRAMWAYS.—The tramway line is shown by dots.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE INSTITUTION.

SIR,—The Institution of Electrical Engineers is the principal corporate representative of an important and increasing profession. In its early days, and especially when it existed as the Society of Telegraph Engineers, it was the principal exponent of the scientific aspect of electrical progress, and attracted a large number of gentlemen only indirectly connected with practical engineering.

Under those conditions it was appropriate that the Council should have been composed to some considerable extent of professors and similar representatives of purely scientific effort.

The Council, which has the responsibility of nominating its own members, has always given due, if not excessive prominence, to this idea, with the result that at the present time, notwithstanding that the membership now includes a very large number (in fact, a considerable majority) of electrical engineers actually engaged on important work, that body consists of:

10 actual or nominal professors.
4 physicists.
11 present or past representatives of Government departments, including naval and military officers.
7 electricians and electrical engineers.
—
32

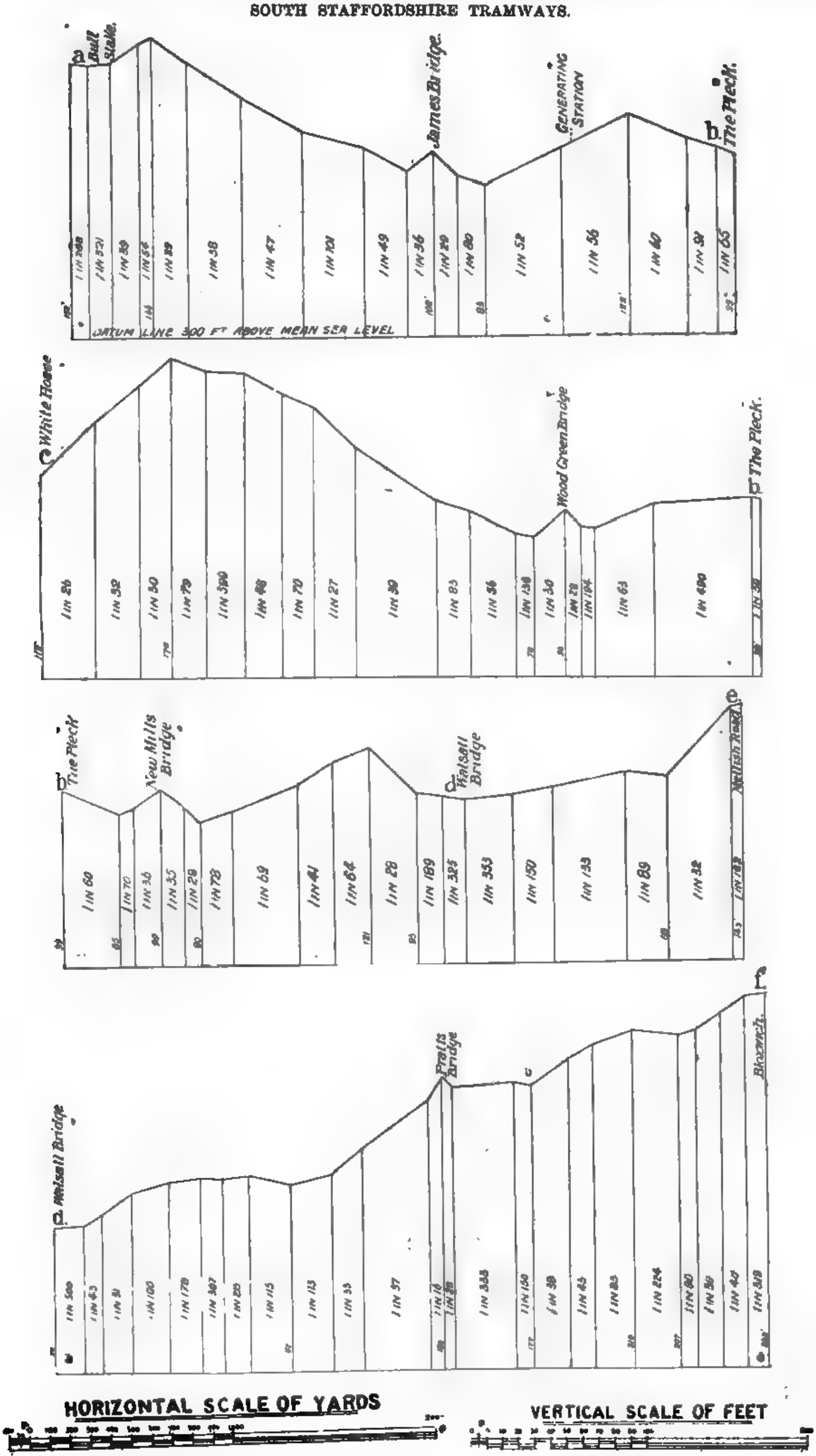
Or, omitting the vice and past presidents, it consists of

5 actual or nominal professors.
7 present or past representatives of Government departments, including naval and military officers.
3 electricians and electrical engineers.
—
15

From a consideration of the above list, which the most vivid imagination would have difficulty in recognising as representative of the present membership of the Institution of Electrical Engineers, we turn with relief to the Institute of *Civil* Engineers—an association which has earned the respect not only of this, but of all civilised countries, and whose principles and procedure may with advantage be imitated by other societies aiming at similar objects.

Their council is composed almost exclusively of engineers

SOUTH STAFFORDSHIRE TRAMWAYS.



Diagrams of Gradients.

in actual practice; it contains only six representatives of Government departments, and no professors.

It must not be considered from the above remarks that any professor who sits on the Council of the Institution of Electrical Engineers is not in every respect an ornament to that Council, and that his presence there does not give satisfaction to the whole body of members and associates; for we fully believe that the contrary is the fact.

In approaching this question we wish to deal exclusively with numbers, and we have neither intention nor desire to approach the subject from the point of view of the personal or contingent qualifications of individuals; for, notwithstanding that we, in company with other members, entertain a high personal regard for each and every member of Council, we feel that it is imperative, in the interest of the Institution, that that body should be truly representative, no class or interest predominating over others.

We have accidentally commenced with the professional element, but there can be no doubt also that the various departments of her Majesty's Government have at the present time a representation much in excess of their share in general electrical work, and that some of the seats held by both the above-mentioned classes might with advantage be distributed amongst other branches of the profession.

We know that our views as expressed above are shared by a large and influential section of the Institute, and we believe also by some members of the Council, who would have given effect to them had they been supported by any general expression of opinion.

We do not advocate, as politic or possible, the making of any immediate radical change in the constitution of the Council, but we do advocate a gradual modification of it by the nomination, on the part of the Council, of new members actively employed in constructive work to replace others retiring in rotation, until a more equal balance be attained.

As the date of the annual election is approaching, we have taken the liberty of bringing this subject forward through the medium of the Press in order that an opportunity may be afforded to members of the Institute of expressing their opinion on a subject which we are assured is attracting serious and increasing attention.—Yours, etc.,

R. S. ERSKINE. E. MANVILLE.
ALFRED E. MAVOR. JOHN RAWORTH.
A. A. C. SWINTON.

London, Nov. 7, 1892.

THE BRIGHTON AND HOVE ELECTRIC LIGHT COMPANY AND THE BRIGHTON CORPORATION.

SIR,—Your readers may probably have seen a recent leading article in the *Daily Telegraph* referring to the differences that have arisen between the Brighton and Hove Electric Light Company, Limited, and the Corporation of Brighton (copy enclosed). The chairman of this company, Mr. Robert Hammond, wrote a letter to the *Daily Telegraph*, which that paper did not publish. I venture, however, to send you a copy of this letter for publication, believing that the attitude of the Brighton Corporation is one of great moment, and of close interest to the members of the electrical industry.—Yours, etc.,

ALFRED S. HODGSON, Manager.

[COPY.]

To the Editor, "Daily Telegraph."

SIR,—In one of the leading articles of your to-day's issue you refer to the friction existing between the Brighton and Hove Electric Light Company, of which I am chairman, and the Corporation of Brighton. I feel certain that I may rely upon your known desire to set forth both sides of a question to afford space for the following explanation of the electric lighting question at Brighton.

I may remind your readers that, as an almost universal rule, whenever a corporation has determined to take into its own hands the supply of gas, water, or electric lighting, it has taken over at a valuation the works of the private company that has hitherto had such supply in its hands. The only exception that has been made by any corporation in this country up to the present moment has been made *by the* Corporation of Brighton, the exception being in connection with this very electric light supply to which you refer.

Now, Sir, I think I may say that, however, politicians may differ as to the wisdom of corporation trading, they are all agreed upon the principle that when a corporation determines to engage in an industrial undertaking, it should take over on mutually equitable terms the private concern already in existence which has done the pioneering and established a goodwill.

Up to the present time, at all events, no one has proposed in the case of gas or water companies that corporations should start opposition works and squeeze out the existing concerns by the sheer force of opposition and by a lavish expenditure of the ratepayers' money.

The Brighton Corporation, however, composed, strange to say, principally of tradesmen with very keen notions individually of the sacredness of private rights, hold as a corporate body exactly opposite views, and though the Brighton Electric Supply Works, which my firm founded in 1881, has during the past 10 years fully coped with all demands for electric lighting in Brighton and Hove, the Corporation of Brighton a year ago actually started opposition works, and refused to treat with the Brighton and Hove Electric Light Company on any terms whatever for the acquisition of its undertaking. No wonder that men conducting their business on these lines shut their eyes to the real interests of the town in other directions.

In your leading article you draw attention to the neglect of the Brighton Corporation to light the magnificent sea frontage with the electric light, and you will doubtless be surprised to hear that the company of which I am chairman has made two offers to light the sea-frontage in Brighton, the last offer being dated 6th March, 1890. The offer being to charge the Corporation for the lighting *the same price as gas*, both of which offers were declined with thanks.

You state in your article that the Brighton Electric Light Company is seeking to extend its area of lighting, but if you will grant me a little more of your space I should like to lay before the public the exact facts, as making them public will, I am sure, tend to get justice for the enterprise which the Corporation of Brighton are trying to stamp out.

No application whatever is being made by the company to extend its area, for ever since 1881 the Brighton Electric Light Company has not confined the electric light supply to any particular portion of the town, but has run its wires in every direction wherever the demand arose, the circuit at one time measuring 30 miles.

I may remark, *en passant*, that during all these years the Corporation, which obtained parliamentary powers as far back as 1883, neglected to do any work whatever, and left the company in possession of the field to work up the business.

The undertaking having been started at such an early period of the electric lighting industry, the engineers followed the then universal custom of placing the cables overhead, but in 1888, after being requested so to do by the Board of Trade, consequent on a report made by one of their inspectors, the company made application for a provisional order to place its cables underground. The Corporation, however, not consenting to the granting of the order, the Board of Trade held a local enquiry in April, 1889. No evidence whatever, it may be stated, was tendered by the Corporation of their intention, within a reasonable time, to fulfil the obligations of their provisional order granted to them in 1883. On the contrary, the Corporation opposed the grant of the order to the company upon the grounds that electric lighting was in an experimental stage, that no system was reliable, and that when such was discovered the Corporation intended to supply the light themselves, under the order which had been granted to them, and which, up to the date of the enquiry, and indeed till July, 1889, had been a dead letter.

The result of the enquiry was that the inspector reported in favour of an order being granted to the company for Brighton, but after the enquiry was closed, and when the company had not an opportunity of being heard, or cross-examining, the Corporation sent a deputation to the Board of Trade to assure the President of their intention to carry

out the provisions of their order, and upon which representation the company was refused the order which they had been invited to apply for, and upon the faith of obtaining which they had spent a considerable amount of money in advertising the usual notices, engaging counsel and witnesses to appear at the local enquiry, and other professional assistance.

Upon the order being refused, the Corporation, abandoning their contention that electric lighting was an experiment, advertised for tenders for works to supply the electric light to a small area of the town where the bulk of the company's consumers were situated. Tenders having been received, the Corporation applied to the Local Government Board for sanction to borrow some £30,000, and an enquiry was held at Brighton in April, 1890, by the Local Government Board. At this enquiry the company appeared and stated their case. A petition signed by nearly 10,000 ratepayers was also presented by Mr. J. L. Wood in opposition to the scheme. A very strong minority of the Corporation was also opposed to the sanction and expenditure of such a large sum of money in this direction, as it was pointed out and proved to the inspector that an advantageous offer had been made to the Corporation by the company. The proposed expenditure by the Corporation was, however, sanctioned, and the Corporation works erected. The Town Council confidently expected that the opening of the works a year ago would result in the immediate ruin of the company, but, to the surprise of the Corporation officials, the company has gallantly held its ground, beating the Corporation at every point, and actually doubling its business during the past 12 months.

On the other hand, the company is able to say that since its applications, commencing in 1889, for provisional orders, the directors have made every endeavour, as originally suggested by the Board of Trade, to come to terms with the Corporation. Last autumn (1891) they succeeded so far as to enter into a draft agreement with the Lighting Committee of the Corporation for the purchase by the Corporation of the goodwill and undertaking of the company so far as it related to the supply and sale of the electric light within the borough. The draft agreement was submitted to the Corporation by the Lighting Committee with a strong recommendation for its acceptance, but the Corporation, although the majority of its members have admitted that the company have done the town a great service during the years they have been established, refused to sanction it, and only last Monday, to more effectually try to crush the company, the Corporation have resolved to further extend their area, and to apply to the Local Government Board for a further loan.

This most recent move of the Brighton Corporation has doubtless been caused by the appearance of the statutory advertisement of the company giving notice of its intention to again apply in the coming session to the Board of Trade for a provisional order.

I am sure that the public, with the facts before them, will join with me in the hope that the company's order may be granted, and that the Board of Trade will not, by refusing the order, assist a Corporation armed with statutory powers, and backed by practically unlimited credit, to work a gross injustice by destroying a trading company already weakened by the heavy expense of supplying light through its experimental stages, and a company which has been of the greatest service to public and private consumers in the borough during a period of 10 years, and during a time when the Corporation, though they possessed statutory rights to supply electricity, failed to put them in force.—I am, yours obediently, R. HAMMOND.

Chairman, Brighton and Hove Electric Light Company, Limited.

From the "Daily Telegraph," November 2, 1892.

"The Brighton authorities do not appear to realise the responsibilities of their position. Already they have won an unenviable fame as being a long way more retrograde and dilatory than most of their rivals in other seaside towns. What visitor to Brighton, for instance, does not come away mournfully impressed with the opportunities lost along the sea-frontage, the ugliness of the piers, the ridiculous inadequacy of the Aquarium, the mean aspect of many of the streets, the pitiable squalor of the beach? Hastings, St. Leonards, Eastbourne, Portsmouth, are all handsomely lit with the electric light. Why does the magnificent range of three miles—from Hove at one end to Black Rock on the other—present so cheerless an aspect of struggling and flickering gas lamps? The recent meeting of the Brighton Town Council gives us some explanation of problems like these, and sheds on the parochial intelligence of the authorities a far clearer light than they are at all inclined to afford to the inhabitants of their benighted city. It seems that considerable jealousy exists between the Corporation and the electric lighting company. Both supply houses and shops in certain districts already, but both are now applying for extended powers to increase the area of their operations. In their mutual bickerings it is needless, perhaps, to say that the public in general and the ratepayer in particular are sent to the wall, and left to console themselves with the reflection that London-by-the-Sea is more painfully neglected—we will not say than any other town of the same size, but than any watering-place of any pretensions. Nobody expects the Corporation of Brighton to consist of practical electricians. Perhaps most people would be satisfied if they only showed themselves men of common business capacity. If, however, they feel themselves unable to solve the question of how the town they misgovern should be lighted, let us recommend them to pay a visit to St. Pancras, where the electric light not only illuminates the thoroughfares and private establishments with wonderful brilliancy, but is also supplied at a rate which occupiers of houses in other quarters of London often find themselves constrained to envy."

INSTITUTION OF ELECTRICAL ENGINEERS

The first meeting of the autumn session of this Institution was held last night at the Institution of Civil Engineers, Great George-street, the president, Prof. Ayrton, F.R.S., in the chair.

Before the ordinary business of the meeting, which was the discussion of Mr. Swinburne's paper on "The Problems of Commercial Electrolysis," which appeared in our issues of September 30, October 7, and October 14 last, the PRESIDENT briefly alluded to the loss sustained by the society in the death of Mr. Edward Graves, who was treasurer for many years and not long since president.

GENERAL WEBBER moved a resolution expressing great sympathy with Mrs. Graves and the family. General Webber referred to his recollections and to those of his colleagues of the late Mr. Graves in every position which he had held. Every colleague looked upon him not only as a superior but as a friend. He was quite sure that this resolution of sympathy with Mrs. Graves would meet with cordial support.

Mr. SPAGNOLETTI seconded the resolution, and corroborated all that General Webber had said of the late President.

The funeral, the PRESIDENT said, was at Hammersmith Cemetery on Saturday, 12th inst., at 11 o'clock.

The resolution was carried unanimously, and the secretary was requested to convey the terms of the motion to the family.

Mr. Cooper opened the discussion on Mr. Swinburne's paper, saying the thanks of the members were due to Mr. Swinburne. Mr. Cooper had for years been connected with the Hermite system, and thought that the members would like to hear a description of a going concern that was a success. That process was first shown at the Antwerp Exhibition. Experience then showed that the apparatus was not practical. Subsequently Mr. Hermite, in conjunction with Mr. Cooper, designed the present apparatus. [This has been described in our columns]. Platinum gauze in ebonite frames is used as the anode. In practice it is found that there is no attack on this anode. In six years' working not more than one anode has had to be replaced. Diagrams of the apparatus were shown. Experience shows that the conditions in actual practice are continually varying, and the matter is not so simple as theorists imagine. In the electrolysis 1,000 volts and 5 amperes is the usual electrical condition for electrolysing the magnesium chloride solution. He hoped some day to contribute a paper dealing completely with the subject. The present electrolyser is the survival of the fittest. They had tried to use carbon, but

found it disintegrated, and gave blacks to the pulp which certainly was not bleaching. The use of copper had to be avoided, because it dyed the pulp green, and so on with other materials.

Mr. Falkenstein referred to the use of electricity in tanning, and contended that the endosmosic flow going on when the current was used hastened the action of tanning.

Mr. Stepney Rawson would say a word with regard to one or two points in the paper. Mr. Swinburne's cost of a kilowatt-hour is put at a farthing, and thought to be a ridiculous cost, but Mr. Rawson hardly thought this was correct when applied to commercial electrolysis. Mr. Rawson thought Mr. Swinburne wise in stopping at the dynamo terminals when considering cost, but if leakage and parasitical currents were concerned, a farthing was too little. He had tried carbon, but only under certain conditions, and when least expected would it work. With regard to zinc and lead and the difficulty in treeing, the process used with the Elmore burnisher removed that difficulty.

Mr. Cross, who had been interested in the Hermite process since its introduction, referred to the discussions which had occurred between Mr. Hermite and Dr. Hurter as to the exact chemical and mechanical effects which went on in the process. The essential matter in dispute was the ratio of bleaching accomplished—that is, the chemical work done to the watts expended. The amount of bleaching that could be carried out by one ton of bleaching powder at a cost of £7 or £8 could be done be done by electrolytic means at from £2 10s. to £4. Dr. Hurter stated that from his experiments the cost was £22 to £40. It was evident that there was something quite wrong here, and not a mere discrepancy. In their own experiments (Hermite) they had found that 90 per cent. of the theoretical effect was obtained. Since then they had carried out an experiment and found in ordinary conditions, instead of having simply oxidisation, there was also chlorination. Even in laboratory experiments, 14 per cent. went in by-paths, while with the Hermite process there was no such loss. These facts went to prove that electrolytic bleaching might be more economical, but the economy depended on the conditions present. He added that in French paper mills, certainly as scientific in their processes as our own, the Hermite process had been working for five or six years, and had given continuous satisfaction, and it must, therefore, be pronounced a commercial success.

Prof. Perry thought it would be desirable to have actual figures of the cost of the electrolytic as compared to the bleaching process.

Mr. D. Fitzgerald thought the thanks of the members, especially the younger members, should be given to Mr. Swinburne, for bringing forward a subject so likely to become so important as that of electrolytic processes. With reference to the material to be employed as anodes, he referred to the use of lithanode, which was perfectly indifferent to hydrochloric acid so long as the action continued. He showed a piece of lithanode used that day for nine hours in hydrochloric acid for producing chlorine. In conjunction with Mr. Faulkner, who had large experience, he had come to the conclusion that chloride of magnesium as a substance to be electrolysed was impracticable. Experiments had shown that after exposure to the solution for a long time the lithanode became coated with a white substance which suggested chloride of lead, but was really a magnesium hydrate, as could be seen by scraping, when the peroxide beneath is intact. The fact was extremely important in bleaching, and would confirm what had been stated as to abnormal power expended in electrolytic bleaching. In experiments he had since conducted with Prof. Perry and Prof. Meldola they were surprised to find that there did not seem to be any strict proportion between the current used and the resultant chlorine produced. His own assistant, Mr. Burman, a rising electro-chemist, had carried out experiments for him on this point, watching hour by hour the effect produced in such electrolytic action, and had found that after a certain strength of chlorine had been produced, that there seemed to be a cessation of action, and even an actual disappearance of the gas. The fact fact appeared to be that chlorate was formed in considerable abundance at ordinary temperatures, and he therefore thought that the use of magnesium chlorate would have to be given up. This transformation would probably account for the failures that had hitherto been unaccountable. They could no doubt be attributed to the undesired formation of chlorates. He would point out, especially to the younger members, the very many openings that might be opened up by electrolytic processes of dealing with chemicals. He would quote as instances the conversion of arsenious acid into arsenic acid by electrolytic means in considerable quantities. Again, the conversion of ferro-prussiate of potash into the ferri (red) prussiate, the purification of sulphuric and hydrochloric acid by the elimination of lead and iron or other impurities.

Mr. Faulkner, who has been engaged with Mr. Fitzgerald in these experiments on bleaching for several years, stated that the lithanodes shown to the members had been in constant use for three years, while some had been in use as long as four years. Prof. Perry and others had been asked to witness some abnormal working which was not thoroughly understood, but which he thought Mr. Fitzgerald rightly attributed to the formation of chlorates. It was on account of this abnormal working that he agreed with Mr. Fitzgerald that magnesium chloride was not the best, nor by any means a suitable material for electrolysing for bleaching purposes.

Mr. Swinburne asked whether oxide of magnesium always appeared on the plates, but not getting a direct answer, he asked whether the appearance of the lithanode plates differed when used in the vertical position to what they did in the horizontal position.

Mr. Faulkner replied by pointing out that a part of the exhibit consisted of plates which had been used vertically.

Prof. S. Thompson thought the discussion of commercial problems without actual details of cost a waste of time, and agreed that the difficulties experienced could not always be foreseen in the laboratory. He referred also to processes failing, not because they ought to fail, but because of the way in which they were carried out, giving as an example a paper mill, in which electrolytic bleaching had been abandoned because the bleaching and dyeing of the pulp were attempted in the same vat, the result being it proved too costly for dye. He then referred to the real want of knowledge of many processes when the intermediate actions had not been thoroughly examined, and to the greater activity of chemicals in the nascent conditions. In all cases the minimum E.M.F. required for a particular purpose should be known, as often too great E.M.F. was a defect, and stopped the action. He also referred to the difference between cyclic and non-cyclic processes, the former often being commercially practicable, while the latter was not.

The discussion was then adjourned to the 17th inst.

ABSTRACT OF REPORT ON TRIALS OF PARSONS'S CONDENSING STEAM TURBINE, USING SUPERHEATED STEAM.

BY PROF. EWING, F.R.S., M.I.C.E., CAMBRIDGE UNIVERSITY.

In December last I carried out a series of trials of Mr. C. A. Parsons's new condensing steam turbine, to determine the consumption of steam under various grades of output (vide *E. E.*, vol. ix., p. 34). The machine tested was a steam turbine coupled with an alternate-current dynamo, capable of an output at the rate of 100 kilowatts, or 100 Board of Trade units of electrical energy per hour. It was then found that the consumption of steam was 37lb. per electrical unit when the machine was running under its full load of 100 units per hour, 50lb. per unit when the load was 50 units per hour, or one-half of the full value, and [illegible] per unit when the load was reduced to one-third of its full value.

I have now to report the results of a further series of trials made during the present month, with the object of testing how far the efficiency has been improved by certain recent changes and by the use of superheated steam. The same turbine was used in these as in the former trials, but some additional rings of turbine blades were inserted at the high-pressure end to enable it to deal more effectively with pressures up to 115lb. per square inch (absolute), the vacuum was improved by the use of a larger air pump and by admitting the injection water at a point of the exhaust pipe close to the turbine, and there was a new governor. The main factor in the improvement which has now been brought about is, however, the use of moderately superheated steam. The improvement demonstrated by these new trials is very marked. Thus, in the present turbine with steam superheated [illegible] above the temperature of saturation, the gross amount of feed water is 28.4lb. per electrical unit generated when the machine is working at full load, and 32lb. per unit at half load. By raising the superheating further (to 125deg. F. above saturation) the consumption at full load is reduced to 27lb. per electrical unit. Comparing these figures with those of the former trial, it will be seen that the consumption of steam has been reduced by about [illegible] per cent. What makes these results specially important is the consideration that there is nothing in the construction or working of the turbine to make it likely that the use of superheated steam will be attended by any drawbacks such as have been experienced in engines of the ordinary type. The steam works without friction, it comes into contact with no rubbing surfaces, and there is no packing to be injured. [Here comes a description of the engine which we need not reproduce.]

The governing of the machine tested was accomplished by a novel and extremely effective appliance. Steam was admitted to the turbine in a series of gusts by the periodic opening and closing of the double-beat lift valve. This valve was operated by means of a steam relay in mechanical connection with the turbine shaft, so that the valve was opened regularly once in every [illegible] revolutions of the shaft. The duration of each gust was controlled by an electric solenoid, which was connected as a shunt to the field magnets, but was compounded so as to keep the volts constant. The core of the solenoid was hung from the end of a long lever. The fulcrum of this lever was periodically moved up and down by means of a link connecting it with the eccentric which also served to drive the oil pump. The other end of the lever controlled the valve of the steam relay. Each periodic movement caused a gust of steam to be admitted to the turbine, the duration of the gust depending on the height of the distant end of the lever. The effect was, that at full load the gusts became blended into an almost continuous blast, the valve closing only momentarily, or not at all, in each of the periodic movements; under any lighter load each interval of admission alternated with an interval, during which the steam was completely shut off. The action of the governor was most satisfactory. The periods of admission were so frequent that they caused no material throbbing of speed nor any variation of volts sensible on a voltmeter. There was no hunting, and the freedom from friction was greater than I have seen in any governor. I repeatedly threw the whole load, amounting to over [illegible], on and off suddenly, without causing more than a momentary variation in the volts. The governor was sensitive, quick, and certain in its action to quite an exceptional degree.

By applying an indicator at the admission end of the turbine chamber, below the double-beat valve, observation was made of the pressure during the periodic admission of steam; this was done by pulling the paper-drum of the indicator as steadily round as possible by hand while the pencil rose and fell. Figs. 1 and 2 are examples of diagrams obtained in this way. In Fig 1 the load was about one-half the maximum; in Fig. 2 it was about three-quarters The pressure which these diagrams show during admission is about 4lb. less than that shown at the same time by a pressure gauge on the steam-pipe above the governor valve.

The machine tested was primarily constructed to generate alternate currents up to 50 amperes, with a potential of 2,000 volts, and in some of the trials the original alternate-current armature was used. But thinking it desirable to make the tests of efficiency depend on measurements of continuous rather than of alternating currents, in order to avoid any uncertainty which may be held to attach to estimates of the work spent in an alternate-current circuit, I suggested to Mr. Parsons the desirability of winding a continuous-current armature specially for these trials He adopted the suggestion, and most of the trials have accordingly been made with a continuous current armature, wound to give 400 amperes at 250 volts. The original exciter was still used to supply current to the field magnets.

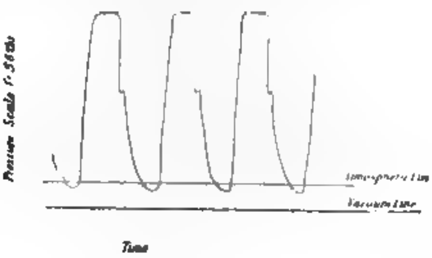


FIG. 1

It may be said at once that the results of the continuous current trials, where the electrical measurement of the work done is of a perfectly simple and straightforward character, are in close agreement with those of the alternate-current trials.

The main armature was about 2ft. 6in. long over the body by 9in. in diameter. The weight of copper on it was only 33lb., or ¼lb. per kilowatt of output.

Steam for the turbine was supplied, at a pressure of 100lb. per square inch by gauge, from a locomotive boiler which was capable of giving enough for the full load of 100 units per hour. The feed-water was measured by putting it through a tank, the graduations and total capacity of which I checked by weighing water into it. The contents of this tank were delivered into a second tank, from which the feed-pump drew its supply, and in which the level of the water was adjusted to have the same value at the beginning and end of each period of observation. The level of water in the boiler was kept as nearly as possible constant throughout.

In all the statements which follow of the results of these trials the quantity of feed-water named is the gross quantity supplied to the boiler, no deduction having been made for leakage, blow off at the safety-valve, or other loss.

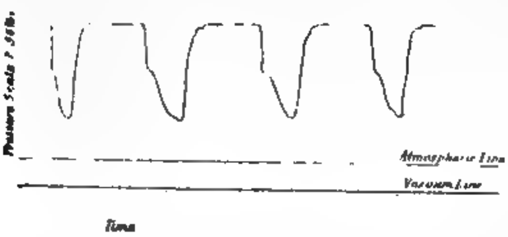


FIG. 2.

On its way to the turbine the steam passed through an improvised superheater consisting of eight 9ft. lengths of cast-iron pipe, 8in. in internal diameter. This superheater was placed in the main boiler flue, and except in a special series of trials noted below, was heated merely by the hot gases from the boiler tubes The draught was forced by a steam jet from an auxiliary boiler. Notwithstanding the small size of the improvised superheater, this sufficed to bring the steam from 338deg. F., the temperature of saturation, to about 400deg. F. In a special series of trials extra superheating was produced by lighting a furnace built for that purpose in the brickwork enclosing the superheater. With the help of this furnace the temperature of the steam in these special trials was raised to about 465deg. F.

Three separate sets of trials were made, August 11 to 15, 1892. In the first set the steam was superheated by means of the hot gases from the boiler furnace only. The temperature approached but did not exceed 400deg. F., which, as the boiler pressure was 100lb. per square inch above the atmosphere, corresponds to about 60deg. of superheating. In this set of trials the continuous-current armature was used, and the amount of feed-water was determined for six different grades of output, from no electrical load up to a load in which the output was at the uniform rate of 102 Board of Trade electrical units per hour, the current being spent on a bank of coils. The results of this set of trials are set forth in Table I, below. The output stated is the amount of electrical work done upon the external circuit, and does not include the output of the exciter. The volts were measured by three Cardew voltmeters, which were tested against each other, and one of them against a Thomson balance. The amperes were measured in the following way: A low-resistance frame consisting of many bare thick wires of platinoid grouped in parallel was arranged as a shunt to a mirror galvanometer, which was provided with a strong controlling magnet, so that the whole current of about 400 amperes could pass without causing an inconveniently great deflection, and without heating the wires of the shunt materially. In series with this was placed (1) an Evershed ampere-meter which had been carefully calibrated by reference to a Thomson balance, and (2) two Siemens's electro-dynamometers, one of which could take the strongest current while the other was suitable for comparatively weak currents only.

TABLE I.—Trials with Continuous-Current Armature, with Steam superheated by the Gases from the Boiler Fire only.

Pressure by gauge on boiler, lbs. per sq in.	Temperature of steam, deg. F.	Load in electrical units per hour.	Feed-water per hour in lbs. Total.	Per unit.
96	335	0·1	480	—
102	365	10·2	760	74·5
100	356	27·0	1,110	41·1
102	400	49 2	1,590	32·3
100	390	74 5	2,170	29·1
103	398	102·0	2,900	28 4

Vacuum in full-power trial: By mercury column at exhaust, 27½in; by gauge on condenser, 28¼in. Barometer, 29·9in. Temperature of injection water, 73deg. F. Speed 4,500 revolutions per minute.

The constant of the shunted mirror galvanometer was determined in the low-power trials by comparing its deflection with the readings of the Evershed and of the more sensitive of the two Siemens's instruments. These were then cut out to allow stronger currents to pass, and in the trials under heavy load a further check on the constant of the mirror galvanometer was furnished by the readings of the larger electro-dynamometer. The mirror galvanometer, the constant of which remained unaltered throughout, served to connect the readings of all the currents, from the lightest to the heaviest loads The agreement between the various measurements was perfectly satisfactory.

(To be continued.)

LEGAL INTELLIGENCE.

HOPKINSON v. ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY.

Alleged Infringement of Patent.

We must postpone notes of the evidence in this case—if notes are required—for a future issue. As a matter of fact, the case was somewhat abruptly adjourned on Monday because of the startling evidence produced by the defendants. After the examination of Mr. Crompton and Mr Raworth, Mr. J. E H. Andwews was put into the box, and his evidence completely took the plaintiffs by surprise, whereupon they asked for an adjournment for a week to consider the evidence and their position—that is, to consider whether the case is to continue or not. Mr. Andrews's evidence was to the effect that he had publicly used the three-wire system at Glasgow prior to the plaintiff's patent.

COMPANIES' MEETINGS.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.

The twenty-fourth ordinary general meeting of the Western and Brazilian Telegraph Company, Limited, was held yesterday at Winchester House.

Mr. W. S. Andrews, chairman of the Directors, presided, and moved the adoption of the report and accounts for the half-year ended June 30, 1892. He stated that they had realised their anticipations of a decrease of revenue owing to the adverse state of exchange in Brazil. This was a cause over which they had no control. Another circumstance with which they had had to reckon was a reduction of the tariff. Of the decrease of £20,940 in revenue, no less than £15,539 was due to loss on exchange The increase in the working expenses was due partly to an exceptionally sickly season, and a consequently large doctor's bill, and partly to accidents to their vessels and the necessity of hiring others. For the first time, also, they had had to meet a falling off of business. The excitement of a few years had ceased, and there had been commercial stagnation, from which their Company suffered. Their consolation was that there were already signs of improvement in this respect, and that the exchange, which had been 11½d., was now 1s. 1d., or 1s. 2d. In laying loop and other lines, the Directors had spent the reserve fund—a course which the shareholders had constantly urged upon them The interest from this reserve fund had of course disappeared, and in place of it they had an addition that nearly doubled the whole system, and that actually doubled it between Pernambuco and Montevideo, which was the revenue-earning portion of the line. A small debit balance was carried forward, but hitherto the Directors had not dealt in the deben-

tures which they had power to issue. The competing lines would find it difficult to overcome a service by which they were able to send telegrams from Brazil to London in an average of 30 and 56 minutes.

Mr J Coppes seconded the motion, and it was carried

A dividend equal to 2 per cent per annum was declared, and the proceedings closed with a vote of thanks to the Chairman and the Directors

NEW COMPANIES REGISTERED.

Dominion Electrical Company, Limited — Registered by F. A Rohder, 14, Mincing lane, E C , with a capital of £25,125 in 5,000 £5 ordinary shares and 500 5s. founders shares Object to carry on the business of a telegraph, telephone, and electric light, heat, and power company in all its branches There shall be five directors, the first to be elected by the signatories to the memorandum of association. Qualification, 50 ordinary or 10 founders' shares. Remuneration, £1,000 per annum, divisible

Julius Sax and Co., Limited Registered by W B Styer, 2, Threadneedle street, E C , with a capital of £20,000 in £10 shares Object to acquire the undertaking of producers and suppliers of electricity hitherto carried on by Julius Sax and Co , and to develop and carry on the said business in all its branches There shall not be less than two nor more than five directors , the first to be elected by the signatories to the memorandum of association Qualification, 100 shares or £1,000 debentures Remuneration not to exceed £500 per annum, divisible

New British Electric Installation Contractors, Limited - Registered by Jordan and Sons, 120, Chancery lane, W C , with a capital of £25,000 in £5 shares. Object to acquire the undertaking hitherto carried on at Worcester by the British Electrical Installation Contractors, Limited, in accordance with an agreement expressed to be made between the said company of the one part and the present Company of the other part , generally, to carry on the business of electricians and electrical engineers in all its branches. There shall not be less than three nor more than five directors , the first to be elected by the signatories to the memorandum of association Qualification, £50. Remuneration, £250 per annum, after payment of 6 per cent. on the paid up capital.

BUSINESS NOTES.

Direct Spanish Telegraph Company. —The receipts for October were £2 307, against £2 436

Great Northern Telegraph Company. —The receipts for the month of October were £24 000.

Burton on Trent The authorities propose to obtain sanction for a loan, part of the proceeds of which is to go for electric lighting purposes

Asylum. —The new asylum at Charminster being erected for the Dorset County Council, at the cost of £84,000, should be lighted by electric light.

Edinburgh The pet scheme of Prof Forbes refuse destructors for Edinburgh is being discussed by the Lighting Committee of the Town Council.

Design for Motors. The sum of £10 is offered for the best design for electrical motors. Particulars will be found in our advertisement columns.

Phonophere Company, Limited —This Company has removed its offices from Blomfield House, London wall, E C to Faraday House, Charing Cross road, W C.

Manchester Infirmary. —The Manchester Royal Infirmary Board of Governors have appointed a sub committee to consider the lighting of the infirmary by electric light

Bolton Tramways As will be seen from our advertisement pages, the time has been extended to December 12th for tenders to be received for a lease of the Bolton and suburban tramways

West Bromwich —At the annual meeting of the Council the Estates Committee reported that the Mayor had arranged to provide a temporary installation of the electric light if the Corporation would provide the engine power

Cologne. The price of current at Cologne is equal to 9 6d. per B T U , with discounts from 2½ to 40 per cent. It is expected that the price may soon be lowered The price of gas in Cologne is equal to 3s. 8d. per thousand cubic feet

Lynton —At the monthly meeting of the Lynton Local Board the clerk was instructed to inform the Lynton Electric Lighting Company that as soon as they were in a position to furnish light their application for powers should be granted

City and South London Railway Company —The receipts for the week ending November 6 were £891 against £783 for the corresponding period of last year, or an increase of £108. The total receipts for 1892 show an increase of £1,407 over those for the corresponding period of 1891

Coventry —At the annual meeting of the City Council, held on Wednesday Councillor George Singer was re elected mayor and in replying, referred to the fact that estimates for electric lighting had been received, and that the councillors had under consideration a scheme of electric traction for tramways

Chiswick. At the Chiswick Local Board meeting last week, with reference to the contract with Messrs. Bourne and Grant for electric light in Chiswick, the clerk stated that he had called at the offices of the Board of Trade, and was informed that that Board hoped to send the draft deed very shortly

Electric Railway to Barry Island A special meeting of the directors of the Barry Railway Company was held last week at the general offices, Barry Dock, when the scheme for the construction of an electric railway to Barry Island was naturally discussed, and it is expected the work will be taken in hand forthwith

Auction Sale. On page xvi of our advertisement sheets will be found an announcement relating to a sale of electrical and engineering plant, tools stock fittings stores etc Full particulars are given, and catalogues can be obtained of the auctioneers, Messrs Wheatley Kirk, Price, and Goulty, 49, Queen Victoria street, E C.

Stafford At the last meeting of the Town Council, a communication from the County Council stated that they had under consideration the question of introducing the electric light in the new County Buildings and asked what facilities the Council could offer in the matter The question was referred to the Electric Light Committee.

Friern Barnet At the last meeting of the Local Board Mr Hennessy suggested that the district be lit by the electric light instead of gas Mr Baldwin Latham had stated that the [illegible] at the sewage works could be utilised for the purpose, with an expenditure of about £500 The matter was referred to the Works Committee for consideration

Derby —The Derby Town Council have accepted the tender of Messrs Siemens Bros and Co , Limited of London, at £[illegible] for providing, delivering fixing, testing setting to work and maintaining combined steam engines, alternating and constant current dynamos, condensers and other machinery and apparatus necessary for the production of electric light

Blackpool The Corporation of Blackpool invite tenders for the installation of wires, switches, etc for the electric lighting of the new police station buildings in that town Plans specifications, and form of tender may be obtained on application to J Wolstenholme, borough engineer, Town Hall, Blackpool Tenders to be delivered at the Town Hall on or before November 25, 1892

Melbourne. —The National Bank of Australasia and the Commercial Bank of Australia, the bankers of the Corporation of the city of Melbourne, Victoria, having purchased the debentures, invite applications for a 4 per cent loan of £[illegible] of the city of Melbourne, the price of issue being 98 per cent. The loan is to be applied for the purposes of electric lighting of the city and the extension of the baths and markets

Lundberg Switches We note that, owing to the great demand for Unique switches Mr A. P Lundberg has been obliged to make great alterations at his works at Kingsland whereby to increase his staff and so better keep pace with the increasing demand Already, over 15,000 of these switches have been supplied and considering the very short period they have been on the market, it evidently shows they are greatly appreciated

Hamburg The installation for Hamburg, to be erected by Schuckert and Co , is to be on the continuous current system The municipality has arranged what is considered a satisfactory scale of charges namely, 9½d per B T U for private lighting, half that for industrial purposes, with discounts for large consumers up to 30 per cent The town is to have one fifth of the gross income, and a sliding scale share of profits if these exceed 6 per cent

Bristol The Bristol Urban Sanitary Authority invite tenders for the supply delivery, and erection of underground feeder mains, arc light circuits, junction and house boxes, arc lamps posts and suspension gear Tenders must be made on the prescribed forms, and delivered at the offices of the Authority, 51, Prince street, Bristol, on or before Thursday, December 1. A fee of £2 is required for specification and form of tender, to be returned on receipt of bona fide tenders

West-end Lighting The following is a list of work being done by the Electrical Supplies and Fittings Company, Limited, in the West-end House installation for Lady Sarah Heron, 2, Connaught place W ; H Davison, Esq , 3 Penywern road, S W ; C F Members, Esq , 2, Morton gardens, S W , the [illegible] Company, 74, New Oxford street W , St Jude's Church extension of lighting in schoolroom, West Kensington ; A L [illegible] Esq , 11, Bramham mansions, S W.

Leicester Alderman Lennard, at the monthly meeting of the Leicester Town Council, said the committee had been in hopes they would be able to bring the electric lighting question forward, tenders from 13 firms having been received, but they found on going into the tenders that they were of so technical a character, and required so much careful examination, that they were not prepared to bring a definite resolution forward They hoped to be able to do so at the November or December meeting

Poplar The Poplar District Board of Works have intimated their intention of applying to the Board of Trade for a provisional order enabling them to produce and supply electric light for public and private purposes within their district It is proposed to lay electric mains in the East India Dock road, Robin Hood lane, High street, Poplar, and North street, Bow road, Coborn road, [illegible] road and Fairfield road The provisional order if granted will subsequently have to be laid before Parliament for confirmation

Pontypool. In connection with the Pontypool Electric Light and Power Company, by the invitation of Mr W [illegible] about 90 gentlemen, representing the commercial and public interests of

the county, were entertained at luncheon at The Crown Hotel, Pontypool, on the 2nd inst. Mr. W Pegler presided, and was supported by Mr. I. Butler, J P., Mr. D. A. Vaughan, of Newport, and others. Mr. J. C. Howell, electrical engineer, Llanelly, occupied the vice-chair, and was supported by several prominent Newportonians.

West India and Panama Telegraph Company, Limited.—The report for the half-year ended June 30 states that the revenue was £44,148 against £47,641, and the expenses £28,589 against £24,868. The balance, with £2,122 brought over, makes a total of £17,682. The directors propose to pay interest of 6s per share on the first and second preference shares, and a dividend on the ordinary shares of 6d. per share, tax free, £3,704 being carried over. The receipts of the Company for the half-month ended October 15 were £2,072.

Paisley.—A very lame and impotent conclusion has been arrived at in the Paisley Town Council with reference to the electric lighting. A report was laid before the Council from the Electric Lighting Committee, stating that they had not seen their way to recommend the Council to proceed with the laying down of an installation for the lighting of the town under the order obtained last year, the probable demand for the light not being sufficient to warrant the expenditure involved. It was remitted to the Electric Lighting Committee to further consider and report.

Burnley.—At Wednesday's meeting of the Burnley Town Council, authority was given for the acceptance of the following tenders in connection with the erection of the electric lighting plant: The Oldham Boiler Works Company, for boilers, at £700; E. Green and Son, Manchester, for economisers, at £228; Job Isles, Stanningley, for cranes, at £195; Callender's Bitumen Telegraph and Waterproof Company, London, for cables, at £4,537; the Burnley Iron Works Company, for engines, at £1,600; and the Electric Construction Corporation, Limited, Wolverhampton, for dynamos, accumulators, and switchboards, at £2,056.

Windsor.—The question of the use of turbines for the electric lighting of Windsor is occupying the local papers. Councillor Dyson has advocated their use, and Mr. Fox retorts, in turn, that if the turbines are big enough to use in this way, there was waste of money in putting them in; if not, there is not too much spare power to deal with the water supply. Mr. Dyson's proposal was to use the water power on Tangier Island, and add steam power sufficient to give constant supply to Windsor, Eton, and district, keeping the powers in the hands of the Corporation. He promises a report upon the amount of power to spare and needed.

Shop Lighting in Dublin.—Messrs Clery and Co., of Sackville-street, are the first of the large drapery firms in Dublin to introduce the electric light into their business premises. Their whole establishment was illuminated with the new light last Saturday night, and the change made a marked improvement, more particularly with reference to judging of colours. There are throughout the warehouse 18 arc lamps of the Brockie-Pell type; also 12 32-c.p., 17 25-c.p., and 19 16 c.p. incandescent lamps. The effect of these lamps when they are lighted up at night is to make the warehouse more attractive, and to add to its bright and cheerful appearance.

Companies of the Month.—The following electrical companies were registered during the past month:

Akester Electric Syndicate, Limited, £50 shares	£15,000
Dominion Electrical Company, Limited, £5 and 3s. shares	25,125
Elieson Accumulator (British Patent) Syndicate, Limited, £1 shares	12,000
Julius Sax and Co., Limited, £10 shares	20,000
New British Electric Installation Contractors, Limited, £5 shares	25,000
Unity Electroplating Company, Limited, £5 shares	5,000
United Electric Tramways, Limited, £5 shares	30,000

Eastbourne.—The Board of Trade have forwarded to the East Sussex County Council a copy of some correspondence which had passed between them and the Eastbourne Electric Light Company, in reference to the audit of the accounts of the latter body. The Board of Trade had pointed out that the accounts which they had sent in had not been audited by such competent and disinterested persons as the County Council should from time to time appoint. The company, in reply, gave the names of an eminent London firm of chartered accountants, who acted as their auditors, and said probably the County Council was quite satisfied with their audit. The correspondence was referred to the Finance and General Purposes Committee.

Belfast.—A movement of protest has been initiated in Belfast against the proposed encroachment on Ormeau Park for the purposes of the extension of the gas works premises. The fact of the gas works extending into the park would, it is urged, spoil its advantages to the citizens. The Corporation is moving steadily with the work of preparation for the electric lighting of the city, and it is proposed, as already announced, to supply power for 10,000 for the present, the proposal made to provide for 50,000 lights being defeated. The objectors to the encroachment on the Ormeau Park ask for the abandonment of the addition to the gas works, in view of the expected introduction of the electric light, but the Corporation reply that the increased consumption of gas for domestic cookery and the driving of machinery renders necessary an extension of the works.

Western and Brazilian Telegraph Company, Limited.—The report of the Directors for the half-year ended June 30th, 1892, states that the total earnings amount to £84,022, a decrease of £20,941, and the working expenses to £39,141, an increase of £502. Including the amount brought forward from 1891, the balance to the credit of the revenue account is £49,368, from which has to be deducted debenture interest, and a sum for the debenture redemption fund, leaving £30,268, of which £14,000 has been placed to the reserve fund. This leaves £16,268. The Directors recommend the payment of a dividend of 3s. per share, free of income tax, on the ordinary shares for the half-year, being at the rate of £2 per cent. per annum, carrying forward £1,662. The shareholders will note that the falling off in the dividend is mainly attributable to the heavy loss on exchange, which for the period of which the accounts treat averaged 11¼d per milreis, as against 18d. for the corresponding period of 1891. The receipts of the Company for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £2,834

Electric Pumps.—The Corlett Electrical Engineering Company, Limited, of Wigan, have recently turned out a very neat form of electric pump with motor on one base-plate, to the order of the Astley and Tyldesley Coal and Salt Company. It is designed for delivering some 40 gallons of water per minute against a head of 300ft. through about 800 yards of 3in. pipes. The pump is of the three-throw type, each ram being 3¼in. in diameter, with a stroke of 5in. A Crompton motor of 5 h p. is used, the Corlett Company being agents for Messrs. Crompton. It is series wound, taking 450 volts 10 amperes for 1,200 revolutions. The motor is geared, in the ratio of 36 to 1, to the pump by gunmetal helical gearing, the speed of the pump being 33 per minute. All bearings are of ample strength, with lubrication for continuous running. The pump is placed half a mile from the bottom of the pit, and the current is supplied from existing lighting plant at the surface. The conductors are insulated solid copper wires, run in wood casing or on earthenware insulators. A second plant will shortly be put in, when a separate generator will be also installed to supply both pumping plants.

Sunderland.—The Highways Committee of the Sunderland Town Council have received a report from the borough engineer on the subject of the application of the National Telephone Company for leave to place underground wires with chambers under the streets for testing purposes The borough engineer said that if the chambers were placed under the footpath they would interfere with many private cellars, and in all probability also with future arrangements for the electric lighting wires being laid. If placed under the carriageway they would interfere with about a mile and a half of wood pavement and break up the concrete foundation for that pavement. The chambers were 7ft. deep and about 7ft. square on the surface, and there would be some 37 of them altogether. The road would have to be carried on iron girders. Mr. Routhwaite further stated that, considering the serious nature of application, he had asked Mr Clay how many poles the proposal would do away with, and when the company would be prepared to carry out the work, and the only reply he had received was that Mr. Clay could not tell. The whole subject was referred to the Electric Lighting Sub-Committee to ascertain if anything of the kind had been done in other towns, and also to press for an answer to the questions raised.

Commissioners of Sewers.—The Streets Committee of the Commissioners of Sewers presented a report at the meeting on Tuesday containing a paragraph relative to the memorial from inhabitants of Ludgate-hill asking that the notice served for removal of sign with electric lamps attached at 37, Ludgate-hill, might not be enforced. The committee stated that, having viewed the same, they could only recommend that proceedings be taken for the removal of the said sign as an annoyance within the terms of the City of London Sewers Act, 1848. Mr. J. C. Bell moved that the report be referred back for reconsideration. Mr. Myers seconded. A discussion ensued, in the course of which Mr. Johnson declared that this was an insidious attempt to set aside the laws of the Commission for the benefit of people interested. He believed that if they allowed this application they would have many more in a very short time. The amendment was lost on a show of hands, and the report of the committee approved. The Streets Committee also submitted a letter from the City of London Electric Lighting Company relative to the progress made in supplying private consumers, and recommended that the company be urged to expedite the matter as much as possible. This was agreed to. The consideration of an application from the City of London Electric Light Company with respect to sites for converter stations was adjourned until the next meeting.

Brighton.—The last meeting of the municipal year of the Brighton Town Council was held last week, when the most important matter for discussion was a proposal of the Electric Lighting Committee to extend the Corporation area of supply so as to embrace about two-thirds of the town. Objectors to the scheme urged that the adoption of the proposal would lead to an enormous outlay, and that there was no justification for entering upon this until the Council had been placed in possession of the financial result of the trading in the present area. Alderman Moon, chairman of the Electric Lighting Committee, regretted that no full financial statement could be presented until the accounts had been made up to the end of the year, and asserted that although, as expected, there had been loss on the present undertaking, amounting to £300 in the last three months of 1891, £650 in the first six months of this year, and a slight loss in the third quarter, a profit was now being made at the rate of £900 a quarter. The success was far greater than they anticipated. He explained that, although they asked for power to cover two-thirds of the town, they would only supply the light where there was a prospect of doing good business, and stated that they already had many applications. It was pointed out that agreement to the motion would not prevent objection to the estimates for further work later on. The committee's report was adopted by a large majority.

ELECTRICITY SUPPLY AND ELECTRIC MANUFACTURING COMPANIES. COMPILED BY MESSRS. FAITHFUL BEGG AND CO.

SUPPLY COMPANIES.

Name of company.	Registered in present form.	Allotted areas of supply companies.	Capital as at November 1, 1892. Authorised. Total shares and loans.	Authorised. Shares. Number.	Authorised. Shares. Amount.	Called up. Per share.	Called up. Total shares and loans and present amount.	Results per last Reports. Year ended.	Reserve fund.	Total expenditure on capital account.	Revenue.	Expenditure.	Profit or loss during year.	Dividend per cent.	Price. Sept. 29, 1891.	Price. June 30, 1892.	Price. Oct. 29, 1892.
			£		£		£		£	£	£	£	£				
CHELSEA	Nov. 18, '84	Parish of Chelsea and portion of South Kensington.	100,500	14,000 Ordinary	5	all on 9,277	46,385	Dec. 31, '91	—	74,721	10,173	8,422	+ 1,751	—	—	—	—
				6,000 Pref	5	none	issued	—	—	—	—	—	—	—			
			[Deb.	500 Founders	1	all	500	—	—	—	—	—	—	—			
			30,000 1st Mt. 6%	—	—	—	30,000	—	—	—	—	—	—	6			
			20,000 2nd ditto.	—	—	—	1,700	—	—	—	—	—	—	—			
CITY OF LONDON	July 11, '91	City of London and district of St. Saviour's, Southwark, District Board of Works.	800,000	40,000 Ordinary	10	all on 36,410	364,100	June 30, '92	—	352,752	Particulars are not yet available.				—	10½	10⅝
				40,000 Pref.	10	£2 on 20,000	40,000	—	—	—	—	—	—	—			
			400,000 Debs.	—	—	—	—	—	—	—	—	—	—	—			
ELECTRICITY SUPPLY	June 12, '89	Parish of St. Martin's-in-the-Fields.	150,000	30,000 Ordinary	5	all	150,000	—	no report yet published.				—	5*	—	—	—
			70,000 5% Debs.	—	—	—	47,900	—	—	—	—	—	—	6			
HOUSE-TO-HOUSE	Feb. 20, '88	Districts in Kensington, Wandsworth, and Lambeth.	350,000	57,900 Ordinary	5	all on 8,322	41,600	Dec. 31, '91	—	58,376	8,328	6,078	+ 2,250	+	4¾	3	2¼
				12,000 7% Pref.	5	all on 2,800	14,000	—	—	—	—	—	—	7			
						£2 on 200	400	—	—	—	—	—	—	—			
				100 Founders'	5	all	500	—	—	—	—	—	—	—			
KENSINGTON AND KNIGHTSBRIDGE			100,000 6% Debs.	—	—	—	30,000	—	—	—	—	—	—	6			
	Mar. 29, '88	Knightsbridge district of St. Margaret's, Westminster, and part of St. Mary Abbotts, Kensington.	350,000	50,000 Ordinary	5	all on 15,000	76 000	Dec. 31, '91	—	141,164	13,188	8,806	+ 4,382	2	Shar's issued privately.		
				10,000 6% Pref.	5	all	50,000	—	—	—	—	—	—	6			
				10,000 2nd Pref.	5	none	issued.	—	—	—	—	—	—	—			
			125,000 4½% Debs.	—	—	—	6,200	—	—	—	—	—	—	4½			
LONDON ELECTRIC SUPPLY	Aug. 26, '87	South London Districts, City of Westminster, St. George, Hanover-square, and St. Martin's-in-the-Fields.	1,250,000	200,000 Ordinary	5	all on 111,000	555 000	Dec. 31, '91	—	753,428	15,560	22,[illegible]18	− 6,958	—	2¼	1	⅞
				50,000 6% Pref.	5	all on 49,840	249,200	—	—	—	—	—	—	—			
			250,000 Debs.	—	—	—	—	—	—	—	—	—	—	—			
METROPOLITAN	Nov. 26, '87	Paddington, Marylebone, Soho, St. Giles, Strand, and Holborn.	500,000	49,900 Ordinary	10	all	499,000	Dec. 31, '91	—	486,926	43,747	34,028	+ 9,719	2	10¾	6¾	6¾
				100 Founders'	10	all	1,000	—	—	—	—	—	—	—			
NOTTING HILL	Feb. 21, '88	Part of the parish of St. Mary Abbotts, Kensington.	100,000	6,452 Ordinary	10	all	64,520	Dec. 31, '91	—	67,845	—	—	− 617	—	4	4½	5¼
				2,998 6% Ord. Pref.	10	£7 on 764	5,348		(Began supplying current June 1, 1891)						(£8 pd.)		
				550 Founders'	10	all	5,500	—	—	—	—	—	—	—			
			50,000 Debs.	—	—	—	—	—	—	—	—	—	—	—			
ST. JAMES'S AND PALL MALL	Mar. 2, '88	St. James's.	200,000	19,980 Ordinary	5	all	99,900	Dec. 31, '91	21,820¶	139,458	31,898	21,336	+ 10,562	8½	8¼	8¼	8¼
				100 Founders'	1	all	100	—	—	—	—	—	—	§			
				20,000 7% Pref.	5	all	100,000	—	—	—	—	—	—	7	4⅞	8	8⅛
			100,000 6% Debs.	—	—	—	—	—	—	—	—	—	—	—	(£3 pd.)		
WESTMINSTER	June 30, '88	City of Westminster, Mayfair, Belgravia, and Pimlico.	300,000	59,900 Ordinary	5	all	299,500	Dec. 31, '91	1,400 (Depreciation and sinking funds.)	297,641	19,455	15,313	+ 4,142	‡	5⅝	6¼	5¼
			100,000 6% Debs.	100 Founders'	5	all											

Brush ...	Aug. 10, '89	—	750,000	150,000 Ordinary	3	all on 78,383	235,149	June 30, '92	3,080	—	55,451	27,790	+ 27,861	6	3½	3	3½
				150,000 6% Pref.	2	all on 75,000	150,000	—	—	—	—	—	—	6	2	2½	2¼
			125,000 4½% Perp. Deb. Stock	—	—	—	111,347	—	—	—	—	—	—	4½			
Crompton and Co.	July 31, '88	—	300,000	30,000 Ordinary	5	all on 8,000	40,000	March 31, '92	1,568	—	—	—	+ 15,068	7	—	—	5¼
				30,000 7% Pref.	5	all on 20,000	100,000	—	—	—	—	—	—	7			
						£2 on 5,219	10,438	—	—	—	—	—	—	—			
			[illegible],000 5% Debs.	—	—	—	43,553	—	—	—	—	—	—	—			
Edison and Swan.	Oct. 26, '83	Business confined exclusively to the United Kingdom. Shares allotted only to the Edison Co. and the Swan United Co.	1,000,000	200,000	5	all on 17,139A	85,695	June 30, '92	33,262	—	166,823	92,012	+ 74,811	5	—	—	2¾
						£3 on 89,261A	267,783	The "B" shares are entitled to one-fourth of the profits after a cumulative preferential dividend of 7% per annum has been paid on the "A" shares. During the year 11% has been paid on account of arrears of dividend on the "A" shares, making the total distribution out of the year's profits 18%, and leaving the arrears still to be met £8,262.									
						all on 23,564B	117,820										
Electric Construction ...	May 29, '89	—	750,000	62,400 Ordinary	10	all on 49,900	499,000	Sept. 30, '91	25,000	—	208,604	162,437	+ 46,167	6	6	5¼	4½
				12,500 7% Pref.	10	all on 3,000	30,000										
				100 Founders'	10	all	1,000										
Electrical Power Storage ...			150,000 6% Debs.	—	—	—	125,300	—	—	—	—	—	—	6			
	Dec. 3, '89	—	100,500	20,000 Ordinary	5	all on 15,000	75,000	May 31, '92	—	—	37,046	31,282	+ 5,764	6	—	—	—
						£3 on 3,537	10,611										
Manchester Edison-Swan ...				100 Founders'	5	all on 70	350										
	May 23 '82	—	550,000	50,000 "A" shares	9	£1 on 20,000	20,000	May 31, '92	1,500	—	6,075	3,249	+ 2,826	5	12/6	6/3	5/-
				10,000 "B" shares	10	all	100,000	The "B" shares, which are held by the Edison and Swan United Electric Light Co., Ld., for patents granted, rank for half the surplus profits after cumulative dividends of 5% have been paid on the "A" shares. The arrears of dividend on the "A" shares now amount to £14,500.									
Swan United ...	May 19, '82	Business confined exclusively to Germany and outside Europe. Co. holds more than half the shares of the Edison and Swan Co., and nearly half the shares of the Compagnie Génerale des Lampes Incandescentes.	1,000,000	209,000	5	all on 19,750	98,750	Sept. 30, '91	—	—	52,616	13 578	+ 39,038	11			
						£3½ on 78,949	276,321½	—	—	—	—	—	—	—	5¼	3½	3¾

Reading.—At the Reading Town Council meeting last week, the minutes of the Electric Lighting Committee were read as follows: "At a meeting of the committee on October 20, the town clerk submitted papers which had been laid before parliamentary agents. He also submitted the observations of parliamentary agents on the subject, and several provisional orders granted to companies by the Board of Trade under the Electric Lighting Acts, and called attention to the provisions contained in such orders upon various points specified in the resolution referring this matter to this committee, and also upon other points upon which it may be necessary to protect the interests of the borough. The borough engineer and Mr. McMullen, electrical engineer, explained their views on the matters relating more especially to the system and mode of supply of electrical energy and the method of charge for such supply. The committee carefully considered the matter, and determined on certain modifications which should be made in the proposed clauses submitted on behalf of the company, and also determined on additional clauses which should be inserted in the provisional order for the protection of the Corporation and consumers of electrical energy, and resolved that the town clerk do forward to the company's solicitors their proposed clauses as amended, and the additional clauses, with an intimation that the committee will be prepared to recommend to the Council to give the requisite consent to the company's application for a provisional order if the clauses, as now amended, are inserted therein." This report was carried unanimously, having been moved by Alderman Monck and seconded by Mr. Stallwood.

Llandudno.—The inhabitants of Llandudno are contemplating the proposal to extend the gas works at a cost of £8,000. Mr. Jas. McMaster, writing to a local newspaper, points out that the town is very favourably situated for utilising the electric light. He says: "I am of opinion that for the outlay of a couple of thousand pounds we could produce and deliver, in the town and streets of Llandudno, electricity sufficient to light the whole place all the night through, at a very small annual cost for maintenance. We have an immense volume of water all the year round, streaming down from Llyn Dulyn to the reservoir, from which the town (and Colwyn Bay and Conway at present) is supplied. My suggestion is that a powerful turbine, to drive the necessary dynamos, should be placed in a favourable position on the stream in suitable premises, and the electricity generated and brought thence to Llandudno by the requisite wires, and the whole of the town lighted therewith summer and winter. The cost will thus be a very low figure, certainly not a figure higher than the present charge upon the rates for gas lighting. Llandudno lighted by electricity in the winter time will be a very much more attractive place for both invalid and healthy visitors seeking health and recreation, than the dismally dark and unattractive town it is at the present time. Let anyone try to imagine the difference in appearance which the promenade and all the other leading thoroughfares would have if lighted by glowing electric lamps from that which they now exhibit under the yellow light of 16-candle gas. The whole of the Great Orme's Head would be standing out in promontories of light and shadow, and would be a continual advertisement of the town to all travellers from Mostyn to Bangor by the railway, and passengers by the Atlantic liners from Point Lynas to Liverpool. The introduction of electricity for lighting purposes in Llandudno would set free the £520 worth of gas now consumed in the public lamps, which may then be sold at a profit for private consumption, and I have no doubt many of our enterprising shopkeepers would hastily avail themselves of the opportunity to illuminate their premises with the electric light, and so set free more gas for other purposes." Llandudno is certainly a town which should early adopt the electric light, and a little private negotiation would perhaps put the matter into practical form.

Plymouth Tramways.—The Plymouth Corporation, having recently acquired the street tramways, called in the opinion of Mr. J. Clifton Robinson, as expert, to value the lines and advise as to their future working. He considers the price paid—£12,500—a moderate one, and advises certain extensions which would measure 1 mile 39 chains, and cost—allowing for the proportion of rolling-stock and equipment—some £15,000. After strongly recommending the erection of a depôt on the piece of Corporation ground adjoining the Technical Schools, Mr. Robinson has proceeded to deal with the future efficiency of the lines. He speaks very decidedly. "I have no hesitation in saying that a far higher measure of efficiency and success would be achieved by the adoption of electric traction. Immense strides have been made in the development and operation of electricity for tramway purposes during the last few years. Indeed, within five years I have seen the installation of electricity as a motive power on more than 300 different lines of tramways in the United States of America, Canada, and the Continent. These lines aggregate over 3,000 miles of tramway and street railway, successfully operated under nearly every known condition of climate, gradient, and city conformation. One important point to be kept in view by the Corporation in considering the proposition to change from horse-power to electricity is that the overhead-wire or trolley system, as recently adopted at Leeds and proposed for adoption in other large cities in the United Kingdom, can alone be regarded. The reason for this is that the introduction of the overhead wires entails little interference with the existing mode of track construction. In order to convert existing lines to this method of traction, it is only necessary to provide what is known as a 'ground return,' which is effected by connecting the lengths of rails at the joints by galvanised iron wire. Track wires are also used connecting at about every 1,000ft. with iron plates sunk in the earth. This arrangement would entail an addition of about **£150 per mile of single track. Support for the overhead wire is**

given by poles of convenient height on each side of the street. Spanning the street is a single wire holding the current wire in position over the centre of the track. Poles, wires, and necessary connections would not exceed £500 per mile. The power station, where electricity is generated by means of steam, gas or water power may be situated near any portion of the line, a central position being preferred. A substantial building amply sufficient for car depôt, workshops, and offices would cost about £5,000. The power plant would consist of two 250 h.p. engines, with boiler of appropriate size, and two dynamos of from 200 h.p. to 225 h.p. The steam power would I estimate cost about £12 per horse-power or £6,000, and the electric plant about £3,600." The carrying out of this scheme would require the provision of 10 electric motor cars at a cost of £600 each. Mr. Robinson estimates the total cost for the electric equipment, including plant, machinery, buildings, cars, etc., at £25,000, giving an entire expenditure on the whole system of £50,000. Against some of this would, of course, have to be set the returns from the sale of the plant and horses, which it is intended to use temporarily, in order that the lines may be worked with as little delay as possible. He thinks that the annual cost of working the electric system would be £7,800, and calculates that the returns would equal 7½ per cent. of the capital outlay of £50,000.

PROVISIONAL PATENTS, 1892.

OCTOBER 31.

19496. **Improvements in and relating to electromagnets and magnetic circuits.** William Lowrie, 117, Bishopsgate-street, London.

19497. **Improvements in electric lamps and in their manufacture.** Hannah Clegg, Brampton, West Norwood.

19543. **Improvements in electric indicating apparatus.** Leicester Bradney Stevens, 40, Chancery-lane, London.

19569. **Improvements in electrical connections.** Osmond Ferguson, 37, Chancery-lane, London.

NOVEMBER 1.

19602. **Improvements in electric switches.** Alexander Bewicke Blackburn, 51, Withington-road, Manchester. (Complete specification.)

19646. **Improvements in the method of supplying electrical energy of required potential to electric current circuits.** William Lowrie, 433, Strand, London.

19655. **Improvements in and relating to a method of and means for heating by electricity.** Henry Gibson O'Neill, 77, Chancery-lane, London. (Complete specification.)

19657. **Improvements in underground conduits for electric cables.** Robert Ewing, 19, Great George-street, Westminster, London.

19665. **Improvements in and relating to telephonic apparatus.** George Septimus Hooker, 27, Martin's-lane, Cannon-street, London.

19671. **Improvements in means for conducting electricity for electric lighting and other purposes.** Martha W. Pollard, 4, South-street, Finsbury, London. (Complete specification.)

NOVEMBER 2.

19690. **Improvements in and connected with the distribution of current in incandescence electric light circuits.** Oscar Axel Enholm, 70, Market-street, Manchester. (Date applied for under Patents Act, 1883, section 103, October 3, 1892, being date of application in United States.) (Complete specification.)

19699. **Improvements in telephonic apparatus.** Daniel Sinclair, 62, St. Vincent-street, Glasgow.

19714. **Improvements in dynamo electric machines.** Henry Chitty, 5, Bolton-gardens, Chiswick, London.

19729. **Improvement in and means or apparatus for rectifying alternating currents for working continuous current motors, and for electrolytical purposes.** Charles Pollak, 33, Chancery-lane, London.

19730. **Improvements in distributing boxes for electric light, and power mains for underground and aerial purposes.** George Joseph Philpott and Amos John Willett, 48, Gloucester-road, Brighton.

19738. **Improvements in portable electric safety lamps and batteries and appliances for charging them.** The Edison and Swan United Electric Light Company, Limited, and Edward Alfred Gunningham, 28, Southampton-buildings, Chancery-lane, London.

19739. **An improved electrical switch.** Edward Lionel Joseph, 115, Cannon-street, London.

19749. **Improvements in the construction of indicating and transmitting instruments for telephones.** Henry Harris, 9, Warwick-court, Gray's-inn, London.

19758. **Improvements in electric conductors.** William Lowrie, 117, Bishopsgate-street, London.

19761. **Improved means for obtaining electricity on board ship.** Howard Ralph Maltby, 37, Chancery-lane, London.

NOVEMBER 3.

19771. **Improvements in and relating to telephonic instruments.** James Muirhead, 96, Buchanan-street, Glasgow.

19821. **Improvements in alternate-current transformers for variable loads.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Messrs. Siemens and Halske, Germany.)

19834. **Improvements in and relating to telephonic switching apparatus.** Alfred Roslin Bennett, 45, Southampton-buildings, Chancery-lane, London.

NOVEMBER 4.

19874. **Improvements in means or apparatus for regulating the supply of electrical energy to lamps and other apparatus.** Edward Pindar Davis and Adrian Charles Collins, 55, Chancery-lane, London.

19880. **The manufacture or production of an improved anode for use in electrolytical processes.** Thomas Parker and Alfred Edward Robinson, 47, Lincoln's-inn-fields, London.

19881. **Apparatus for controlling electric pressure in alternating-current circuits.** P. Walter d'Alton and John Ambrose Fleming, 28, Southampton-buildings, Chancery-lane, London.

19886. **Improvements in making house connections with electric lighting mains.** William Fuller, 24, Southampton-buildings, Chancery-lane, London.

19889. **An improved electric clock.** Adolph Edward Vela and Gaston Hervieu, 9, Warwick-court, Gray's-inn, London.

NOVEMBER 5.

19910. **Improvements in reflectors for electric and other lamps and lights.** Percy Gartner Ebbutt and John Benjamin Verity, 128, Colmore-row, Birmingham.

19916. **Improvements in electrical conductors, and in means of making connection therewith.** Claude Theodore James Vautin, 1, Queen Victoria-street, London.

19919. **Electric light conductors.** George F. de Solome, 17, Hanover-street, Islington, London.

19927. **Improved means for lighting railway cars by electricity.** Johannes Kerner, 6, Lord-street, Liverpool. (Complete specification.)

19953. **Improvements relating to the construction of electrodes for electrolytic purposes.** James Charles Richardson, 6, Bream's-buildings, Chancery-lane, London.

19959. **Improvements in the means or apparatus for measuring electricity.** Edward Howard Percy Humphreys and William Friese Greene, 55, Chancery-lane, London.

19960. **Improvements in ammeters and voltmeters.** Edward Howard Percy Humphreys and William Friese Greene, 55, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1880.

13057*. **Telephones.** Marinovitch and Szarvady. (Amended.)

1890.

13735*. **Electro-metallurgical operations.** Hoepfner. (Amended.)

1891.

17631. **Electrolytic manufacture of tubes, pans, etc.** Elmore.
20886. **Electric lights for ships.** Martin and Hunter.
21651. **Electric circuits.** Dingle and Urquhart.
21702. **Electrodes for accumulators.** Thompson. (Kerckh...)
21849. **Dynamo electric machines.** Paterson and Emmerson.
21923. **Driving clockwork electrically.** Berry.

1892.

13225. **Electric lamps.** C. A. J. H. and H. E. R. Schroeder.
15477. **Melting metals, etc., by electricity.** Kennedy.
15799. **Galvanic batteries.** Nation and Nelson.
15898. **Electric circuits and cables.** Newton. (Barrett.)
16014. **Phonographs.** Mackintosh.
16071. **Electric locomotives.** Soley and others.
16434. **Electric light switches, etc.** Dorman and Smith.
16469. **Electric lamp fittings.** Webber.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	[illegible]
Brush Co.	[illegible]	[illegible]
— Pref.	[illegible]	[illegible]
City of London	[illegible]	[illegible]
Electric Construction	[illegible]	[illegible]
Gatti's	[illegible]	[illegible]
House-to-House	5	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	[illegible]	[illegible]
Liverpool Electric Supply	[illegible]	[illegible]
London Electric Supply	[illegible]	[illegible]
Metropolitan Electric Supply	[illegible]	[illegible]
National Telephone	[illegible]	[illegible]
St. James'	[illegible]	[illegible]
Swan United	[illegible]	[illegible]
Westminster Electric	—	[illegible]

NOTES.

Carbons.—A new arc carbon factory is being erected at Paris.

Japan is to have a cable-laying steamer for native engineers.

Lyons is shortly to have an overhead conductor system of electric traction.

Quebec. — An overhead electric railway is being organised in Quebec.

Brussels.—Steps are being taken, says the *Financial News*, with a view to laying another electric tramway at Brussels.

Electro-chemistry.—It is stated that one of the largest banks in Paris is taking up the question of electro-chemistry.

Accident.—Sir M. Morrier-Williams has had his right forearm slightly fractured in Switzerland by a fall from an electric car.

Extension.—The New York *Electrical Engineer* has moved into new and handsome extensive premises at 203, Broadway, New York.

Belgian Railways.—The authorities of the Belgian State railways have decided to carry out experiments with electrical traction at Liège.

Brest.—Besides three engines by MM. Weyher and Richemond, the fort of Brest will have in its installation five engines by MM. Sautter, Harlé, and Co., who will also furnish all the electrical plant for the installation.

Industrial Electricity.—M. Marcel Deprez is giving a course of lectures at the Conservatoire des Arts et Métiers, at Paris, on industrial electricity, more particularly from the point of view of electric transmission of power.

Electric Photography.—Mr. F. J. Smith read a paper on "Photography" before the Oxford Junior Scientific Club, dealing with the question of taking photographs of extremely short duration of exposure by electric spark.

Electric Heaters.—The electric heating business is becoming an important industry in Canada. A number of Ottawa capitalists have recently formed a company to work the Ahearn patents for electric heaters, ranges, and ovens.

Electric Drying-House.—A drying-house for timber is nearly completed by Mr. Parr, at the Caudere, Ottawa, Canada. It will be heated by electrical apparatus, and will be the first building in existence for drying timber electrically.

The First Electrolier.—The huge and elaborate electrolier constructed by Messrs. Verity for Edison's exhibit in 1881, is being offered to the American electrical engineers as suitable for exhibit at Chicago as "the first electrolier" ever made.

Electricity at the Coalfields.—A paper was read last Saturday before the Manchester Association of Engineers by Mr. B. H. Thwaite, on "Economic Possibilities of the Generation of Electromotive Force in the Coalfields and its Application in Industrial Centres."

Oxford.—The electric light, adopted wholly at Brasenose College and Hertford College, and partially at some other colleges, is voted a great success, although there is some difference of opinion as to its suitableness for reading purposes. Perhaps there is need of more frosted lamps.

Central Stations.—A special course of six lectures will be delivered before the Society of Arts, under the Howard Bequest, on Friday evenings, commencing January 13, 1893, by Prof. W. Cawthorne Unwin, F.R.S., on "The Development and Transmission of Power from Central Stations."

Ward Arc Lamps.—The Ward Arc Lamp Company are now making a twin arc lamp, having two sets of carbons taking five amperes to burn direct on a 110-volt circuit. This lamp gives an equivalent in light of a 10-ampere lamp, and is useful where a customer only requires one lamp. The ordinary Ward arc lamps are being made at the rate of 400 a week.

Country Machinery.—If contractors, wishing to obtain country mansion practice, were to supply as a regular article an engine that would act as a fire-engine pump, and would also pump water, drive a chaff-cutter, a cream separator, and a circular saw, with a dynamo for electric light thrown in, they would get more orders for electric lighting than they now procure.

South Kensington Electric Railway.—It is stated that it is intended to proceed next session with the Bill for the construction of an underground electric railway from Paddington to South Kensington, the scheme having been altered to meet the objections of the opponents of the line, which it is proposed to extend to Clapham Junction, passing under the Thames.

Firth College Popular Lectures.—On Saturday evening, at Firth College, the first of a series of lectures on "The Electric Current" was given before a numerous and appreciative audience by Mr. R. Lehfeldt, a member of the professional staff of the college. The lecture, which was to a large extent introductory, was illustrated by numerous interesting experiments, and repeatedly applauded.

Westinghouse.—Rumours are freely circulating that within a month the Westinghouse will become part of the American General Electric Company. This statement will probably require a denial to follow. It is more likely that a reciprocal arrangement will be come to that the General Electric may use the new Westinghouse lamp on condition that all litigation against Westinghouse be withdrawn.

Chicago Exhibition.—It will scarcely be believed in this country that the ridiculous determination is said to have been made by the Chicago authorities that the gates of the exhibition shall be closed at seven o'clock in the evenings of all ordinary days. It is hardly likely this idea can be held for long. What on earth would the electric lights be for if the fair is to be an early closing association?

Siemens Electrodynamometer.—Messrs. Siemens and Halske have introduced, we see it stated, a modification of their well-known electrodynamometer to prevent a magnet in the neighbourhood affecting the coils carrying the current. The single solenoid is replaced by several arranged around the same axis, so that they are repelled to the same extent that they are attracted by any neighbouring magnet.

Circulating Battery. — M. Serrin has recently brought out a continuous circulating battery, illustrated in *L'Electricien*, which is a simple sulphate of copper battery with zinc and carbon electrodes, but with a syphon arrangement for keeping up a continuous circulation. Two vessels, from and to which the liquid flows, are reversed every morning. The battery, it is claimed, has a low internal resistance, and is constant and economical.

Electric Railways and Telephone Companies.—A case has just been decided by the New York Court of Appeal on the respective rights of electric railways and telephone companies to earth. The Court decided that the telephone company could no more justly complain of its loss from grounded currents than it could, if by jarring

of loaded vehicles in the street, its delicate and sensitive instruments were impaired or destroyed. The railroad company was given costs.

Municipal Telephones for London.—Mr. Barrs placed the following motion on the paper of business for the meeting of the London County Council: "That it be referred to the General Purposes Committee to consider and report whether the Council has power to establish and work a telephonic system in London similar to the system established and worked by the municipalities of Christiania, Liverpool, Manchester, and other towns, and if so, to consider and report as to the desirability of exercising such powers."

Fire in Regent-street.—On Wednesday afternoon the firemen at the West-end stations were called to a shop alight in Regent-street, and it was found that the premises of the London Stereoscopic and Photographic Company, at 106 and 108, Regent-street, were in flames. In his official report Captain Simonds states that the cause of the fire was "overheat of electric wires," which had set fire to the shop window and its contents. Deliveries from a hydrant were sufficient to subdue the flames, but the house and shop suffered by smoke and water.

Appointment.—Mr. H. F. Lewis, who has for many years been general manager and secretary of the Western Counties and South Wales Telephone Company, now absorbed by the National Telephone Company, has retired from the post he has hitherto occupied, and has accepted the important position of general manager to the London Electric Supply Corporation. The immense energy and long experience of Mr. Lewis in connection with electrical and telephonic matters will doubtless prove of great value to the company with which he has now associated himself.

Electrical Imagery.—There is an extraordinary "electrical group," by Mr. Outcault, illustrated in the *Electrical World*, as intended for the transportation building at Chicago, which, if a fair specimen of the decoration intended for the exhibition, does not say much for the designing power of American sculptors. Semi-draped, awkward figures all out of drawing, even if trampling on Gramme rings and poising huge telegraph tappers, do not make an electrical group; and when one weak-kneed damsel is seen holding a field magnet of ½cwt.—though her arms are as stout as a fish-wife's—the absurdity and crudity of the design are manifest. The most fanciful of all sciences can surely furnish better imagery than this.

Presentation to the New Telephone Company's Manager.—The employés of the New Telephone Company met at the company's Manchester offices on Monday evening, and presented Mr. G. J. Somerville with a silver tea service on the occasion of his leaving Lancashire, where he has been manager since the opening of the exchange early last year, to take charge of the company's metropolitan district. In making the presentation Mr. W. A. Valentine referred to the esteem in which Mr. Somerville was held by all the employés of the company, and said that the great progress of the exchanges in the Lancashire district was in a large measure due to his untiring energy. Mr. W. A. Valentine has been appointed district manager of Lancashire.

Canada and Imperial Telegraphs.—At a meeting of the Ingersoll (Ont.) Board of Trade last month, the following resolution relating to the extension of direct telegraphic communication throughout the Empire was passed: "That this Board concur in the suggestion that the extension of the telegraph system to all parts of the British Empire is well worthy of grave consideration, and that a commission appointed by the British Government would be the best and most practical means of calling attention to the scheme, elicit information, and suggest a feasible plan for accomplishing such a desirable and far reaching result, and which would have the effect, in the opinion of this Board, of stimulating the trade and commerce of the Empire."

Limits to Telephony.—Messrs. Bedell and Crehore, in a paper on the effects of self-induction and distributed static capacity in a conductor, come to the conclusion that the difference in the rates of propagation and decay of waves of high and low frequency doubtless constitutes the limitations to the use of the telephone. As the several harmonic components of a complex tone advance along the conductor, they keep shifting their relative phases according to the difference in their rates of propagation, and also change their relative intensities according to the difference in their rates of decay, thus changing the resultant combination tone and materially altering its quality. These effects are always present in circuits containing distributed static capacity, but are not so marked when there is no self-induction.

Canterbury Cathedral.—The authorities of the Canterbury Cathedral have recently entered into a contract with the gas company to be supplied with gas from the works and have abolished their own plant. This decision is regarded with much disfavour in the city, as the deleterious effect of the deposited carbon is very noticeable in cathedrals and churches, and it is thought every effort should be made to introduce the electric light. The late architect was in favour of that step long ago, but at that time the expense was too great. The present consulting architect should be approached with the idea of introducing the more cleanly light into one of our loveliest monuments of Gothic art. If the consent of the authorities can be obtained by the proposed Canterbury and Dover Electric Company, a desirable customer would be secured and a national treasure would be safeguarded.

Telegraphic Rates to the Antipodes.—A conference of Australasian Agents General was held on Tuesday at the Colonial Office with the Marquis of Ripon on the subject of cable rates to the colonies. The Earl of Kimberley was present at the conference, as representing India, and Sir John Pender, M.P., representing the Eastern Telegraph Company. All the agents-general, except the representative of Queensland, were present, with the object of pleading on behalf of their respective Governments against a proposed increase by the Indian Government of 1½ centimes a word for the transit of cable messages to the Antipodes by way of the Indian lines. It was pointed out that before a decisive answer could be given the Indian Government would have to be communicated with, but in every other respect Lord Ripon accepted the request of the Australian colonies. The result of the conference was regarded as most satisfactory by all persons concerned.

Another Remedy.—We commend to our esteemed contemporary the *Electrical Review* the perusal of a little pamphlet which is being scattered broadcast in our [illegible]. Its title is "The New Remedy—the Electropoise," and, according to its author, this new remedy "will make you master of disease," "will cure you of whatever your complaint may be; no matter what its character, the electropoise will cure you of it." Of course, to assist to force this remedy into public favour, there is the usual Press notices and report from a so-called expert. The notices we have before us are from the *Woman's Herald*, and from the *British Journal of Commerce*, *Brighton Standard*, *Birmingham Chronicle*, and the *Weekly Star*. The expert is Peter Auchinachie, Ph.C. (What does Ph.C. mean—Pharmaceutical Chemist?) If so, this is no title, and falls under Prof. Tilden's anathema. We wonder how many will

misread it Ph.D. We do not hesitate to denounce this pamphlet as a tissue of lies, and that no remedy whatsoever, even though compounded of the word "electro" or "electric," has any such effect as is claimed herein.

High-Speed Railway in Austria.—An interesting lecture, which has caused a good deal of comment in the newspapers, was delivered on Saturday, in Vienna, at the Society of Austrian Engineers and Architects, by one of the members (M. Hugo Kostler). The subject was the proposed electric railway for rapid communication between Vienna and Budapest. According to this project, an electric railway would run on the right bank of the Danube at the high speed of 200 kilometres, or 120 miles, an hour, thus reducing the journey between the two capitals from five hours to one hour and a half. The distance between Vienna and Paris, which is now covered in 26 hours, would then only require seven hours, and that between Paris and Constantinople would only take 15 hours instead of 65. The trains would have a single carriage, containing 40 passengers, and could be despatched at intervals of 10 minutes. The differences of grade being taken into account, an electric motor of 200 h.p. would be necessary for each carriage. It is stated that arrangements are being made to test this system between two important centres.

Electric Mine Lamps.—At the general meeting of the South Wales Institute of Engineers, held on Tuesday at Cardiff, Mr. Theodor Raaschon introduced the "Bristol" miners' el ectric safety lamp, and Mr. J. P. Rees an electric safety lamp of another kind. Mr. G. W. Wilkinson (Risca), who had h ad a good deal of practical experience of the use of electric lam ps underground, was asked for his views, and said he had not found them entirely successful as yet. They went all very well for the first three or four months, and then the acids saturated the structure of the lamp, and rendered it practically useless. A gentleman from Lancashire related a similar experience. Mr. Raaschon offered to supply 500 of his solid brass-cased lamps, and if they did not stand a fair test for 12 months at least, the makers would bear the loss. Mr. Bailey agreed to accept the offer. Mr. Wilkinson also offered to give them a fair trial. The president observed that it was most essential that a fair test of the lamps should be made, as if they got a thoroughly sound self-contained electric lamp they would go a long way to ensure safety in the mines.

Newspaper Offices.—A description—with a note of interrogation—is thus given in a recent number of *Lippincott's*, by Mr. J. A. Cockerill, of the offices of the *Chicago Herald*: "What would an *ante bellum* journalist say to a business office with 3,600ft. of floor space flanked by 16 columns of genuine Sienna marble? What would the old-time 'typo' think of a composing-room with its walls of white enamel, its quadruple cast-iron type stand, with cases for 180 men, its electric calls connecting each case with the copy-box, its aerial railway conveying advertising matter up to the business offices, its separate clothes closets for 160 men, its extensive reference library for the use of the proofroom, its marble closets, filtered ice-water coolers, with solid silver gold-lined drinking-cups, its 348 incandescent electric lights and marble-topped lunch counters and tables? What would have been thought of marble bath-tubs for the stereotypers? Of a great central library for the editors and reporters, around which are arranged a score of handsome editorial rooms? What would the old-time journalist say to a publisher's apartments in which all the metal fixtures are oxidis d silver, and all the woodwork solid mahogany; of marble clothes closets, and bathrooms for all employés, and a constant flow of cold clear water day and night from an unfailing artesian well?" Luxurious journalism, this!

Age-Coating of Incandescent Lamps.—Prof. Edward L. Nichols has an article on the age-coating, as he terms it, of carbon in the incandescent lamp, which is given in the *Electrical World*. A number of experiments, which are tabulated, show that the decrease in the relative transparency of the globe is only partly responsible for the decline in light of lamps. After 800 hours, in one case, the relative brightness was only 45 per cent. of the original—the relative efficiency being 51·3 per cent. and the relative transparency of bulb 78·24 per cent. The results are thus summarised: 1. The rate of deposit of the coating in incandescent lamp bulbs is greatest in the early part of the life of the lamp. For example, in the case of a lamp which lasted 800 hours, more than half the coating was deposited during the first 200 hours. 2. The loss of brightness due to the absorbing power of the age-coating is a variable part of the total loss, being greatest in lamps of high initial efficiency. 3. The coating does not appreciably modify the character of that light which emanates from the lamp. 4. The distribution of the coating within the bulb is nearly uniform. 5. No marked difference between heated and unheated filaments appears to exist as regards the density of quality of coating produced from them. Since the writing of this article it has been pointed out by Prof. B. F. Thomas, that in the case of lamps exhausted without the aid of mercury the age-coating is scarcely perceptible.

Double-Decked Railways.—A long and statistical article upon rapid transit takes an important place in the last number of the *Quarterly Examiner*, to which those specially interested in the question might refer. The question of electrical railways naturally occupies a considerable portion of the article, and some views of rather a novel kind are promulgated. The necessity for two kinds of passenger traffic—high speed for long distances and more moderate speeds for suburbs—has led to the suggestion of double-decked railways for London, where sites are so valuable that doubling the width means an enormous expense. Take, for instance, the Cannon-street and Waterloo line. This used to serve for a "shuttle service" of trains between the City and West-end, but has long since been utilised also for main passenger traffic. Why not, it is suggested, surmount the present line with another lighter railway driven by electricity, and so regain for the South-Eastern much of the traffic it has lost? The suggestion is expanded to the proposal to run double-decked railways, the lower or ground floor for high-speed heavy trains, and the upper floor for light single-car electric carriages for shorter distances. It is not all railways which, like the Waterloo line, could erect a superstructure, for tunnels would interfere, but as an alternative for the costly device of underground tunnelling it might serve in certain cases. The real value of the *Quarterly* article is to show that the attention of those in authority is rapidly becoming attracted seriously to electrical railway undertakings, and the proposals which now abound, amongst others that of a high-speed railway for Vienna, mentioned elsewhere, equally indicate that large and important enterprises may soon be undertaken.

Gilding Grids.—The *Electrical World*, commenting upon our announcement of Mr. FitzGerald's discovery of the efficacy of using gilded lead grids for accumulators, has the following editorial note: "Most of the alleged improvements in accumulators deals with the shape and form of the grids to prevent the active material from falling out. But in experiments made in England by Mr. D. FitzGerald, who has done very creditable work in the accumulator field, he attacks the problem in a different way, and, if reports are correct, he has been more successful than those

who try by changing the shape of the holes in the grids to keep the material on them. He goes back a little farther and tries to prevent the layers of sulphate between the active material and the lead surface to which it is held; for it is the layer of sulphate forming, as is well known, on the discharge which is at the root of much of the evil. His experiments seem to show that by gilding the lead plates of the grids, even only quite lightly, the formation of this sulphate is prevented. If such gilding does not develop new and unforeseen difficulties, as most new inventions in accumulators do, it may prove to be one of the most important in the recent development of this much abused apparatus—the lead accumulator." In Mr. FitzGerald's experiments no such difficulties as are above mentioned have as yet manifested themselves, and we are somewhat surprised that this really important invention of Mr. FitzGerald's has not created more outward interest. There are, perhaps, several reasons for this. Some accumulator manufacturers do not require lead grids at all. The greatest manufacturers—the Electrical Power Storage Company—from a business point of view, would seem to favour cheapness rather than extreme efficiency. Something might be done if its cost and the possible deleterious action of chlorine on the gold is not found to stand in its way. We trust this improvement will be well tested by independent parties, and not allowed to become lost to sight.

Cost of Electric Light.—Mr. Arthur B. Gill writes an interesting letter to the *Journal of Gas Lighting* with reference to the cost of electric light as compared with gas. His letter was drawn forth by remarks upon the installation at the National Safe Deposit Company, for which he was contractor. The current here is obtained from dynamos driven off countershaft from the engine which drives the fan and pumps. There are 120 lights of 16 c.p., but only 30 in summer and 45 in winter are used at a time, or an average of two units per hour. "There is no doubt," says Mr. Gill, "that the electric light has cost less than gas for the year 1892, as compared with 1891, in which year the company adopted the Welsbach burners, which effected a saving of 45 per cent. over previous years. An interesting point is that, whereas the fans were driven to ventilate and drive out the products of combustion from the burnt gas (the premises being all underground), they have been almost dispensed with. The power they used to absorb is now given to the dynamo; therefore, the light is produced by the power that was formerly practically wasted in ventilating—the net result being that the consumption of coke, which in 1891 came to £76, was reduced in 1892 to £74. (I admit that coke was cheaper in 1892.) The actual quantity used for producing the light amounted to less than £20. Of course, interest and depreciation have to be added to this, as also a slight increase in wages, which was given to the men to get them to take an interest in the plant. I may say that the wear and tear was inappreciable, and the repairs were nil, as they should be in an installation which is erected in a proper manner, and when the price is not cut down, as is unfortunately the case in most installations." He adds that he produces the electric light at his own house with a gas engine for 1.5d. per unit = 16 lamps of 16 c.p. per hour, which means a consumption of 50 cubic feet per hour, or less than 2d., including oil (gas being 2s. 6d. per 1,000 cubic feet). This speaks for itself, he thinks, as to whether or not large consumers should produce their own current.

Asbestos.—Mr. J. Alfred Fisher, general manager of the United Asbestos Company, has forwarded to us a copy of *an interesting paper* read by him before the Institute of Marine Engineers on "The Mining, Manufacture, and Uses of Asbestos." The paper was illustrated by specimens of asbestos from various countries, both raw and manufactured. It appears that discoveries of this material, so useful to the engineer, are being constantly made, but except from the Canadian and Italian beds the specimens are practically useless for manufacture. Mr. Fisher describes the district in the Susa Valley, Piedmont, where the floss and powder asbestos are obtained, throwing in a romantic touch of history. The second district, about 30 miles long, is in the Aosta Valley, where the deposits are said to be almost inexhaustible. There is a third district, still more important, at Valtellina, the route to which passes Milan and Como to Colico. The Canadian deposits are at a district called Black Lake, between Quebec and Sherbrook. The asbestos-bearing rock is usually some kind of a green serpentine, and in working is first crushed in special machines so as not to destroy the fibre. The long fibre is shaken, carded, and spun, much like cotton and wool, into yarns, tapes, and cloths. In the rubber department it is proofed and made into sheeting, tapes, and rings for steam and other joints, or into cloth and millboard.. A special kind of packing for high pressure cylinders, known as "Victor" metallic cloth, is made by weaving together brass wire and asbestos, and is used in many marine engines. At the company's works at Harefield processes are adopted for utilising every part of the fibre—the shorter lengths being made into millboard, and the fluff and powder into non-conducting composition. The subject of covering steam boilers and pipes has been brought into special prominence by the rule of the Board of Trade that all steam pipes and boilers shall be tested by hydraulic pressure to double the working pressure at stated intervals, the lagging being first removed. This necessitates removable coverings, and non-conducting asbestos mattresses are now made, weighing only 1½lb. to the square foot, removable without trouble. Mr. Fisher points out the numerous other uses for asbestos—the fire-resisting paint for exposed woodwork, funnel paint, asbestos bunker baffle plates to keep off the heat from coal bunkers, and numerous other purposes. The paper is a valuable epitome of the history of asbestos.

Engineering Experience.—As soon as the large number of earnest students who attend the technical college classes achieve their desire—pass through the course and the examinations—they are cast off into the world to shift more or less for themselves. Then comes the great problem what to do to gain experience. Two ways are open to them. One is to seek for some position, no matter much what, that they can obtain without, or preferably with, payment; and the other is courageously to plunge a third time into the bonds of pupilage, and—after already having learnt the three R's and then the "C equals E over R," and the rest—turn to and learn engineering, paying a premium higher or lower, according to the requirements and the purses of the parties concerned. Who to go to? Where to seek? These are then the problems. The first-rate electrical engineers are few, and the pupils they require for premium are many. The fortunate scholar needs to be born with a rich father or uncle in the background to enter here, and then perhaps he is one of half a hundred with scant prospect of learning real engineering design. The spread of electrical science into nearly every branch of engineering might lead intending pupils to go further afield in their quest for experience than hitherto has been deemed advisable. A large number of engineering firms are now starting an electrical side, and with them the students, full of electrical lore and with the power of

testing instruments and dynamos, might really be of service at once, and, besides, would be where full knowledge of engineering method and design can be acquired. The great engineering works of Lincoln, Grantham, Newcastle, Lambeth, and Erith have now their electrical branches as a matter of course, and if the students who wish experience were to bombard the many larger engineering firms rather than overwhelm the few well-known electrical engineers, it might be better for them, both at once and in after life, for the extended experience would lead to that possibility of opening up new branches of application in which the hope of the coming generation of electrical engineers consists. There is also that wide field hinted at by Mr. FitzGerald—the chemists—who already are widely using electricity in manufacturing processes, and the outlook here is not less promising. Further, there are the railway engineers proper. When electricity promises more and more to revolutionise the rapid transit of town and country alike, those men will be most in demand for this work who, trained in electrical schools, have mastered ordinary railway practice, and are capable of carrying to a successful issue the superintendence of the numerous traction schemes that are looming ahead.

Coast Communication in Cornwall.—A great deal of work has been carried out during the past few months in connection with a scheme for coast communication in West Cornwall. Operations were commenced in June last, when the coastguard station at Porthleven was connected by telephone with the Lizard signal station, a distance of 14 miles. From the signal station a wire is carried direct to the house of the chief officer of coastguard, two miles off. There is also a wire from the Lizard station to the Cadgwith Post Office, three miles distant, also having communication with the Cadgwith Coastguard, 300 yards away. From Cadgwith is a wire connecting Coverack, Porthoustock, Porthallow, and St. Anthony-in-Meneage. This communication is *viâ* St. Keverne and Manaccan. Although Manaccan is only a mile across the river from Helford, where there is a coastguard station, it is not at present contemplated to carry the telephone to that station. Nor will a wire connect Helford with Maenporth. There will, however, be communication between Maenporth and Falmouth, but it is regarded as a serious oversight not to connect Manaccan, Helford, and Maenporth, because should a wreck occur anywhere in the Helford river, as has more than once happened, the nearest telephone stations would be St. Anthony-in-Meneage, about two and a half miles distant, and Maenporth, four miles away, whilst the nearest lifeboats which could be summoned would be those at Falmouth and Porthoustock, a wire being laid between these places by way of King Harry Passage. Up to the present, St. Mawes and St. Anthony-in-Roseland are not telephonically connected, but, doubtless, will be in time. During the winter communication will be made between Porthscatho and Caerhayes, the circuit to include Carne and Portloe. Then there will be a circuit connecting Caerhayes, the Greeb, the Dodman, Gorran Haven, and Mevagissey. It is anticipated that this portion of the work will be completed by March. Last week the islands of Scilly were telephonically connected — Tresco, Bryer, St. Martins, St. Marys, and St. Agnes—and this circuit was "spoken" round for the first time on Friday. The work proposed to be carried out next year includes the connection of the following circuits: Fowey to Mevagissey and Fowey to Polperro; Prussia Cove to Marazion, Penzance, and Mousehole; Penberth to Sennen, Porthleden (St. Just), and Pendeen Coves; Trereen Cove (Gurnard's Head) to St. Ives and Hayle; Hayle to Gwithian and Portreath; Portreath to Porthtowan, St. Agnes, Perranporth, and Newquay. It is believed that all the lighthouses around the coast, including the Wolf, Longships, Seven Stones lightship, St. Anthony, Godrevy, Bishops, and St. Agnes will ere long be connected with the circuits mentioned.

Electric Tell-Tale for Coast Defence.—The Portsmouth correspondent of the *Times* describes an ingenious electrical and telephonic apparatus for defending roadsteads, anchorages, and mine-fields by giving warning by visible and audible signals on shore of the approach at night, or during thick weather, of torpedo boats or other hostile vessels, which has just been subjected to experiments extending over several weeks. These experiments were carried out at the mining establishment in Stokes Bay, where the apparatus was witnessed in operation by Colonel Vetch, of the War Department, a committee of Royal Engineers from Chatham, and various officers belonging to the "Vernon." The instrument is called a hydrophone, and its inventor is Captain M'Evoy, the well-known torpedo and submarine mining expert, formerly attached to the Confederate Army. The hydrophone consists of two parts. One part is placed at the bottom of the water outside the anchorage or mine-field at a depth of from five to fifteen fathoms, and the other is fixed on a station on the shore, and the two are electrically connected by cable at distances of from one to five miles. In the present instance the instrument was sunk in seven fathoms, and about 300 yards off Fort Gilkicker. The submerged part consists of a bell-shaped iron case, ⅜in. thick, 20in. in height and extreme diameter, and weighing about 340lb. At the top is fitted a sensitive vibrator or diaphragm enclosed in a copper box. It is formed of a plate of ebonite with carbon attachments, and when the case is submerged the delicate mechanism is kept clear of the water by means of the column of compressed air, which is enclosed as in a diving-bell. No sooner does a torpedo boat approach within a radius of half a mile, or a man-of-war within a mile, than the pulsations of her propellers produce a vibratory movement inside the case. These vibrations are transmitted to the station on shore in the following manner: The electric current from the land battery passes through the vibrating mechanism and also through the apparatus on the shore, in the circuit of which is placed an instrument named a kinesiscope, which is somewhat of the nature of the galvanometer. By means of this the perturbations in the water are communicated to a needle flickering in a graduated arc, and when the oscillations become pronounced the needle is clutched by a magnet at the end of the arc. Contact is thus made, and the vibrations in the submerged case are made visible and audible by means of flashing lights, the firing of a gun, and the ringing of a bell. Telephonic signals are also transmitted through the same current. The whole of these operations were successfully performed in the presence of the visitors. The idea is that for coast defence a number of hydrophones should be sunk in the approaches to a port or dockyard and connected with a central station, and that, as soon as one of them has given its warning of the neighbourhood of an enemy, the information should be communicated to the threatened point by independent cables. It is contended, also, that another field of operations is open to hydrophones in dangerous zones around certain well-known headlands that are frequently fatal to shipping in dense fogs. Captain M'Evoy would connect a danger zone by means of hydrophones with the nearest coastguard stations. By these means a ship would be warned of the danger it was in by the automatic firing of a gun or flashing of a light.

THE SOUTH STAFFORDSHIRE TRAMWAYS.

In describing the South Staffordshire Tramway Company's electrical equipment—just completed over a considerable portion of their line—it is hardly possible to commence by saying that here we have the first steps taken by a system of passenger transit to improve its previously existing methods, and adopt the very newest and latest ideas that have been developed in any country, with a view to greater economy and efficiency.

So far as concerns the fundamental principle that underlies the new electric tramway, it has, of course, been shown in successful operation for some time in this country already, since, indeed, the short length of line at Leeds was equipped on the overhead conductor system, operating continuously thereafter to the present time, with satisfaction to the local authorities and the public.

Nor, so far as concerns electric traction in its broadest applications, can it be said that English people are ignorant of its possibilities or actualities. There are already ten or a dozen lines of railroad or tramway type, either projected or in active operation for the transit of passengers, and the interest aroused by these amongst the general public has been both widespread and deep.

In spite, however, of what has been done in this direction during the past few years, and taking into full account the enormously rapid progress and development of electric traction in the United States, it may be stated with much confidence that the system just inaugurated upon the South Staffordshire tramways will take a most prominent—if not the leading position amongst electric lines, by reason more especially of the improvements and advances that have been effected in its essential details.

It is not to be concluded from this statement—which will, doubtless, receive confirmation at the hands of electrical engineers generally—that previous appliances or methods have proved insufficient or unreliable, nor yet that the new system just introduced is essentially perfect. Even the contractors themselves admit that the stress of daily wear and tear must develop weak points into active faults, but there is also no doubt that the same ingenuity which has overcome so many serious obstacles in this connection may very safely be entrusted with the remedying of defects which no human foresight could well anticipate.

As for the essential differences between the new system and those already at work, it may be said, briefly, that these are such as the conditions of the country make needful, and are also such as the engineer can regard with satisfaction as being consonant with true mechanical principles. English people can, of course, become habituated to anything. They grumble greatly at the unpleasant, but if the matter concerns John Bull's pocket the grumble subsides gradually into an indifferent mutter. There is no doubt that numberless span wires across our streets and a double row of poles along each of them would be freely endured if it can be proved satisfactorily that electric traction, when thus carried on, is far more efficient and economical than the methods previously employed; but when success in the last-named direction is just as readily achieved by doing away with all necessity for cross-wires and a double set of poles, it would seem no more than fair to claim for the system the prominence that it deserves.

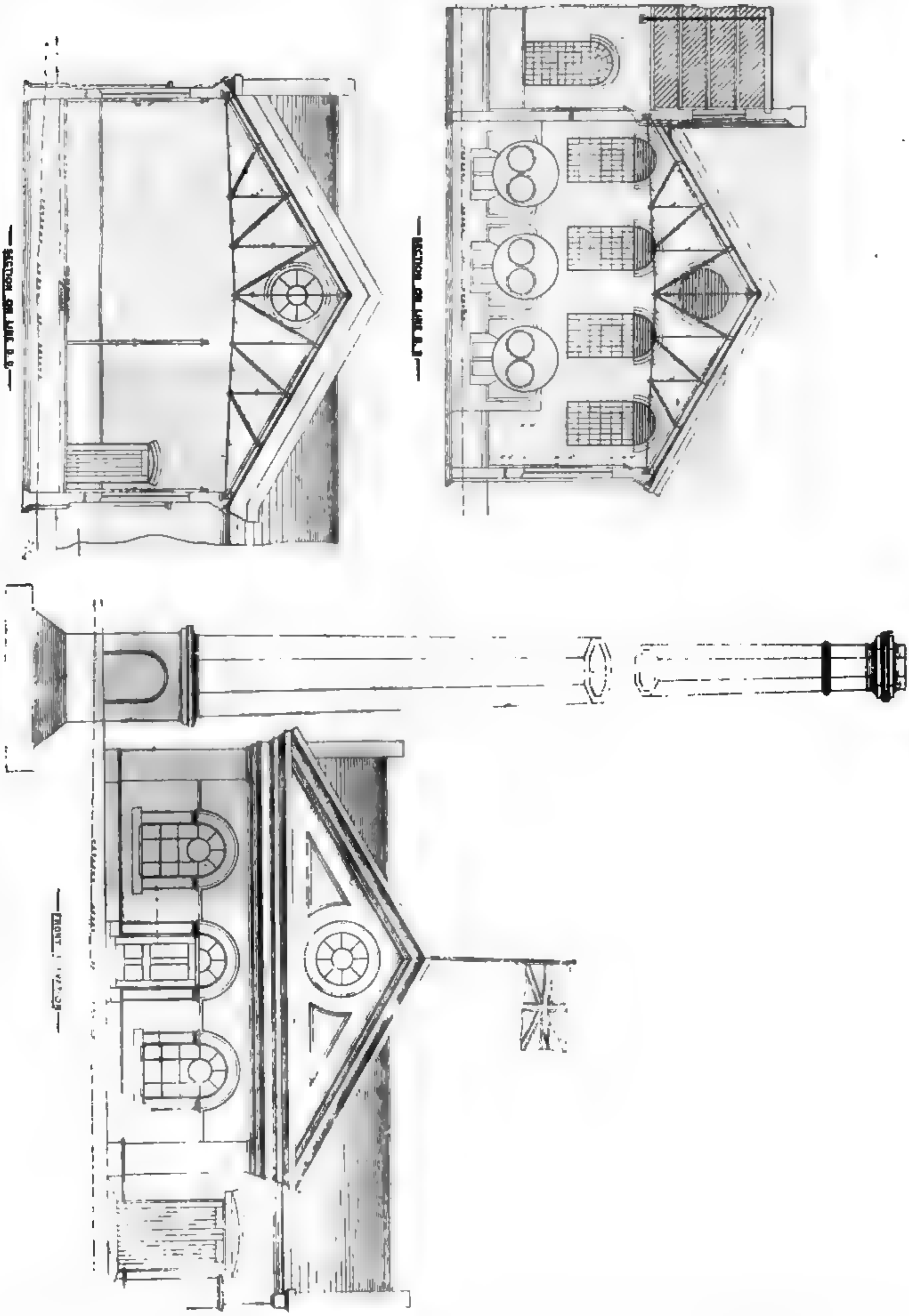
With these introductory remarks, the course is somewhat cleared for a detailed account of the system and appliances now in use on the South Staffordshire line.

View of Generating Station, with Car on Line.

Since electrical energy is the agent employed for operating the line, any description of its leading features might perhaps, to follow out or trace the current of electricity from its origin or introduction to its complete utilisation; and by following this plan it will be more easy to give the essential details in their most suitable order and place.

The electric generating station, from which the overhead conductor system is supplied with electrical energy for operating the car motors in the usual way by travelling connections, is situated at James Bridge, almost in the centre of the district covered by the lines worked electrically. Its position is shown very clearly upon the map which was published in last week's issue. The building itself is of a plain unpretentious nature, with the appearance of having been designed for practical use rather than ornament. It has, however, a frontage to the high road with some claim to architectural embellishments of a simple kind. The chief consideration throughout, however, has been to give plenty of room, light, and air, with lofty roofs and ample window space on all sides. Brick is used throughout for the walls, with stone dressings for the windows and front of the building—a heavy stone cornice giving the latter rather an ecclesiastical appearance that is only destroyed by the high chimney stack.

Alongside the depôt it is proposed to build a new arm from the canal, which runs at the rear of the plot of actually existing, but it is too far off—as may be seen from the plan—to prove of material service, and an early



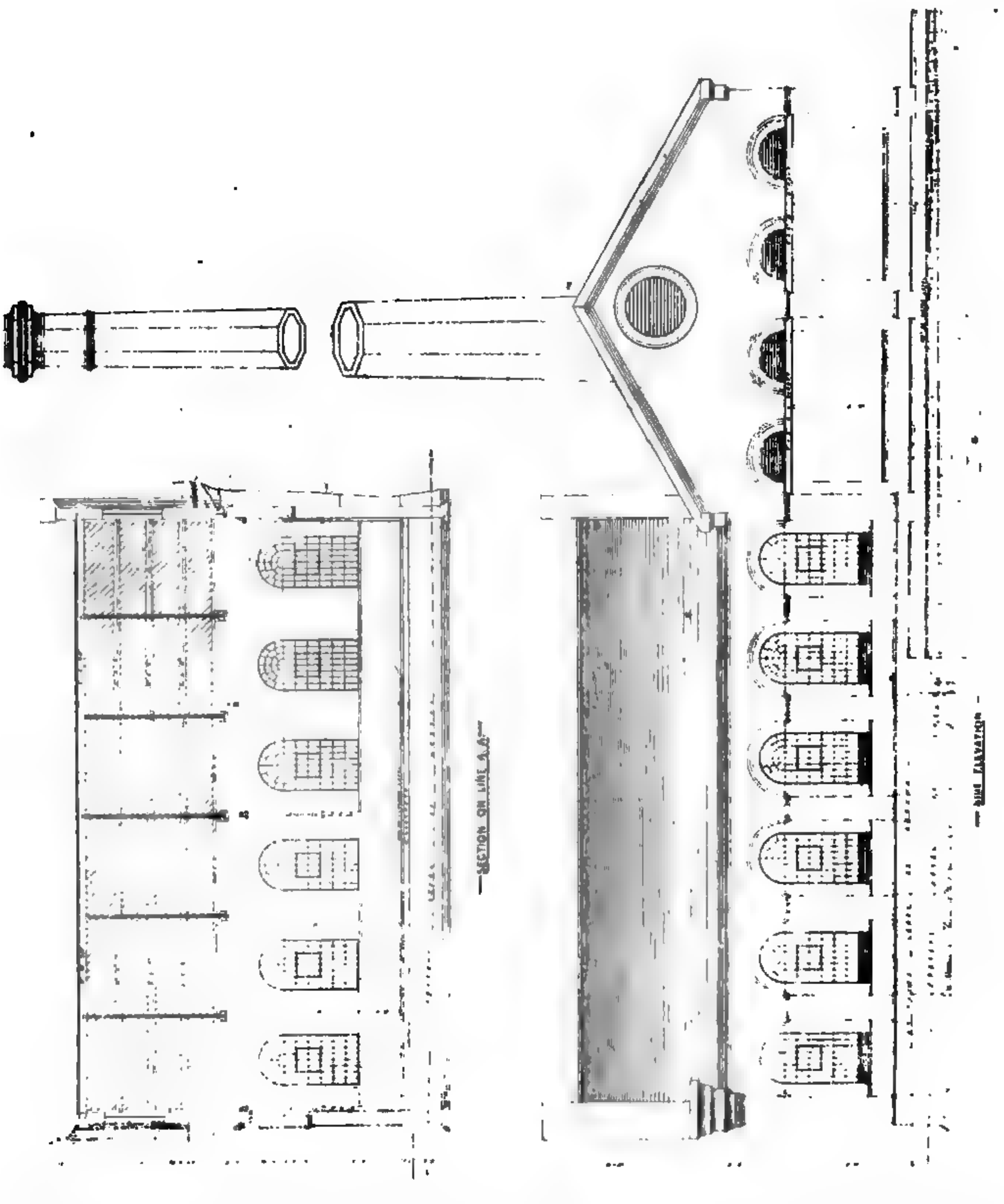
Full and Sectional Elevations of Depot or Generating Station Buildings, showing Boiler House and Engine and Dynamo Room.

land occupied. By this means coal will be taken direct from the barge into the fuel store, thus saving the expense of cartage. There is at present an arm of the canal task, when the line is in working order, will be to complete the new arm. The chimney stack is a substantial erection, but is only noteworthy on account of the climbing

irons built into the brickwork on the inside, so that repairs or alterations may at any future time be carried out with a minimum of trouble and danger.

There comes next to be considered the generating plant contained in the depôt or central station. Three large Lancashire boilers are at present erected for the purpose of raising steam to actuate the engines and, through them, the dynamo generators. Each measures 20ft. in length and 7ft. in diameter, so that they may be regarded as equal to a steam-generating capacity of, say, 200 h.p. each. They are made of steel, with all necessary fittings and appliances, and coming from the works of Messrs. J. Musgrave and Sons, Limited, of Bolton, may be regarded as good examples of Lancashire boilers, having no specially novel features, but representing a type of serviceable and economical steam generators for a purpose where rapid steaming is not so essential as a large steam capacity in case of sudden calls upon the generating station for increase of power along the line.

The three engines to which these boilers supply steam are made by the same firm—Musgrave—and are of the coupled compound horizontal type, with surface condensers. The cylinders measure in diameter 10½in. and 20in. respectively, the stroke in both cases being the same—30in. The valves are of the well-known Corliss type, fitted to both cylinders. The steam pressure employed is 120lb. per square inch. A flywheel, 10ft. in diameter, is fixed to each main engine-shaft, running at 100 revolutions per minute; this, of course, gives a little over 3,000ft. per minute as the velocity of the flywheel rim, and of the ropes which are used to drive the dynamo generators. Each flywheel is grooved for seven ropes, of 1½in. diameter, after the



Elevations of Depot and Generating Station Buildings.

fashion that has been found so successful in many of the large electric supply stations now at work in the Metropolis and elsewhere.

A full supply of water is ensured by the erection of a large tank—shown in the drawings of the depôt published on another page—and in order to secure its good quality for boiler and condenser purposes this reservoir is kept supplied from the South Staffordshire Water Works Company's mains.

Instead of the large sums that have been paid by the tramway company for coke, and other fuel of a more or less smokeless nature, to burn, without creating a nuisance, in the furnaces of the steam tramway locomotives hitherto employed, it is to be hoped that a very great saving will be effected in fuel alone by the adoption of electric energy as the operating agent, since the stationary boilers can be kept satisfactorily at work with fuel costing a good deal less than the 20s. to 22s. per ton hitherto paid for coke of a specially smokeless nature.

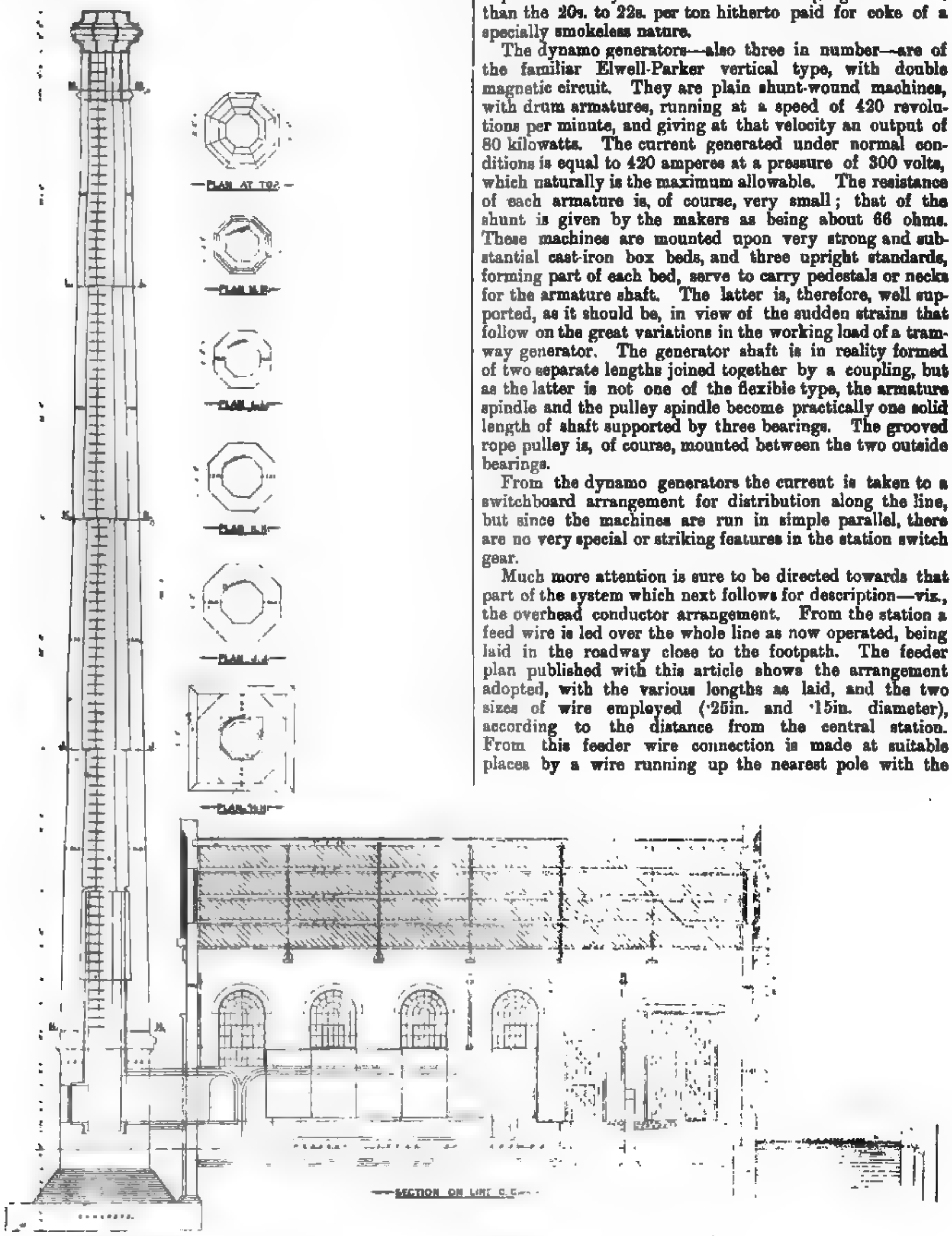
The dynamo generators—also three in number—are of the familiar Elwell-Parker vertical type, with double magnetic circuit. They are plain shunt-wound machines, with drum armatures, running at a speed of 420 revolutions per minute, and giving at that velocity an output of 80 kilowatts. The current generated under normal conditions is equal to 420 amperes at a pressure of 300 volts, which naturally is the maximum allowable. The resistance of each armature is, of course, very small; that of the shunt is given by the makers as being about 66 ohms. These machines are mounted upon very strong and substantial cast-iron box beds, and three upright standards, forming part of each bed, serve to carry pedestals or necks for the armature shaft. The latter is, therefore, well supported, as it should be, in view of the sudden strains that follow on the great variations in the working load of a tramway generator. The generator shaft is in reality formed of two separate lengths joined together by a coupling, but as the latter is not one of the flexible type, the armature spindle and the pulley spindle become practically one solid length of shaft supported by three bearings. The grooved rope pulley is, of course, mounted between the two outside bearings.

From the dynamo generators the current is taken to a switchboard arrangement for distribution along the line, but since the machines are run in simple parallel, there are no very special or striking features in the station switch gear.

Much more attention is sure to be directed towards that part of the system which next follows for description—viz., the overhead conductor arrangement. From the station a feed wire is led over the whole line as now operated, being laid in the roadway close to the footpath. The feeder plan published with this article shows the arrangement adopted, with the various lengths as laid, and the two sizes of wire employed (·25in. and ·15in. diameter), according to the distance from the central station. From this feeder wire connection is made at suitable places by a wire running up the nearest pole with the trolley wire, that hangs from an insulator of ordinary swivelled form at the end of the bracket on the pole.

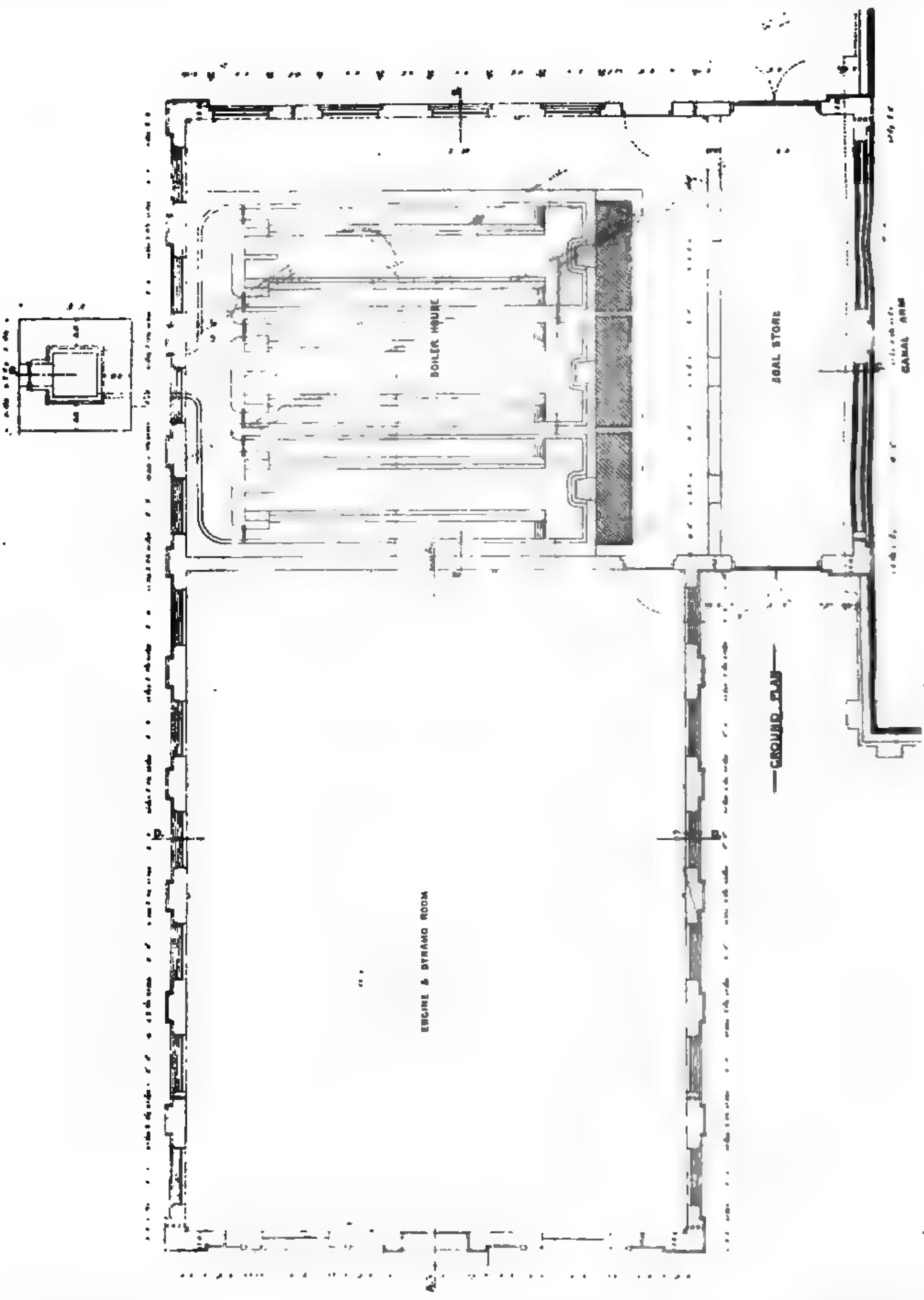
The poles erected along one side only of the road for the purpose of carrying the trolley wire are of neat but plain form.

In detail, however, they present many noteworthy



Sectional Elevation of Boiler House and Chimney Stack, with Sectional Plans of the latter

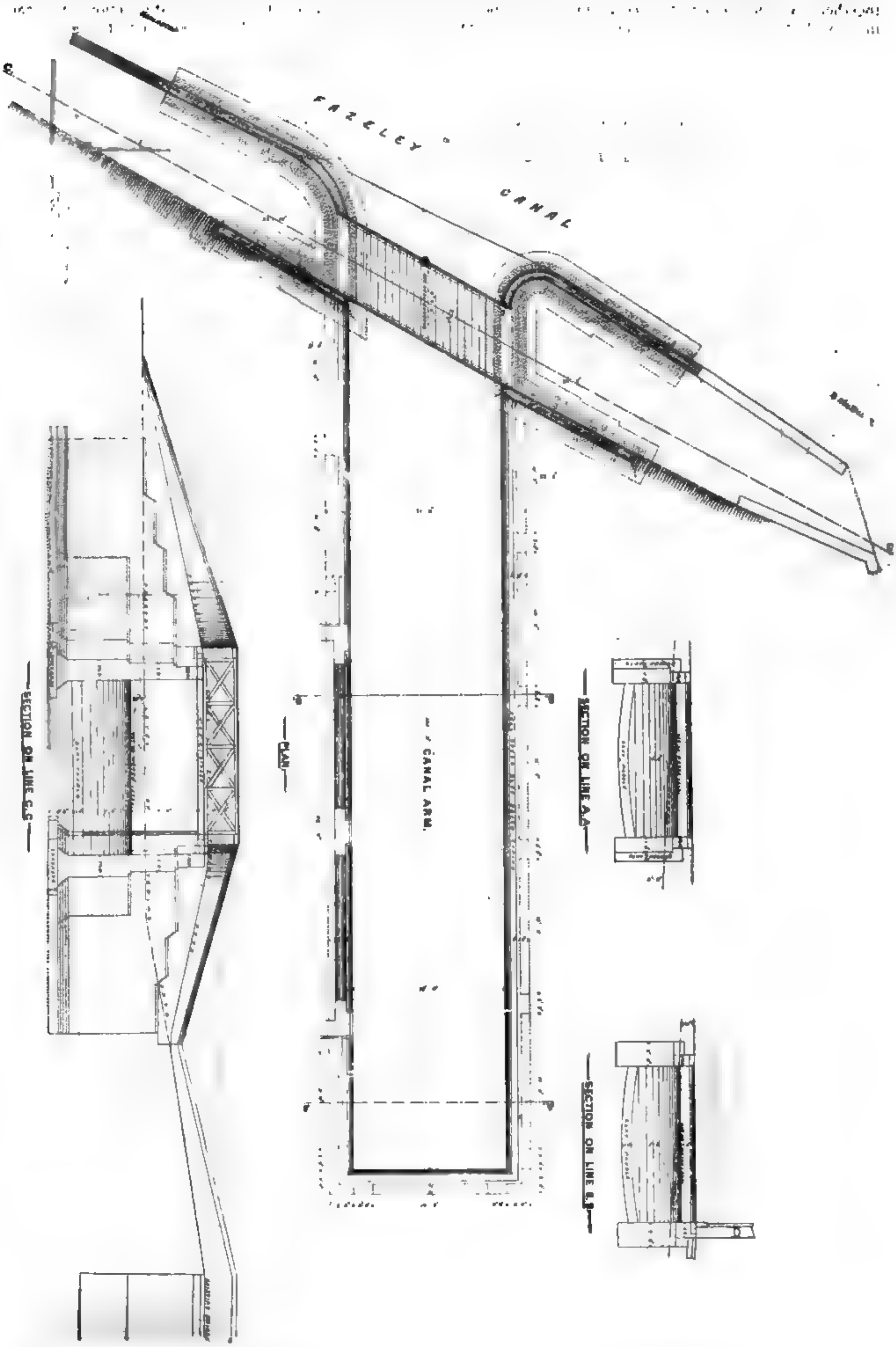
features, and a full description of these poles—their component parts and the manner in which they are put together—will not be out of place at this point, especially in view of the extent to which public opinion must in a



General Plan of Depot or Generating Station Buildings.

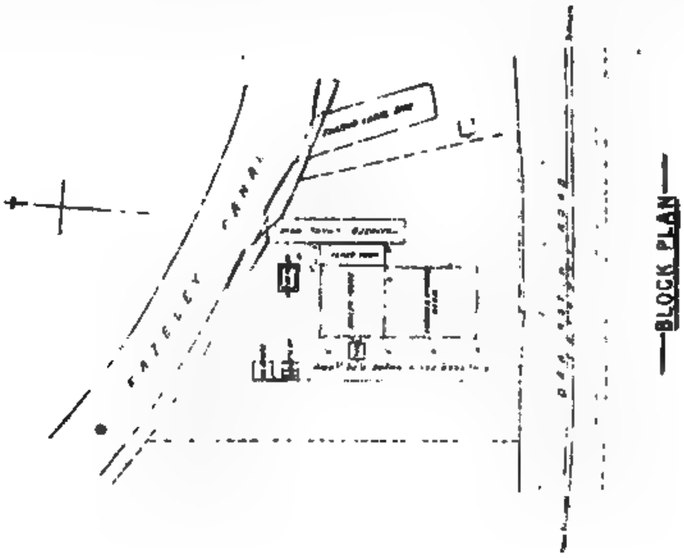
natter of this kind be given free scope for expression as to ;eneral effect. The sizes of poles adopted at present are hree in number—viz., those with bases 6in., 7in., and 2in. diameter respectively. Of the largest type only a · required, these being necessary at points where the strains upon the overhead system are at their maximum—as, for instance, at junctions and terminal points. Else where, and along the intermediate sections, the smalle sizes are employed. All the poles are of mild-steel tube the 12in. having ½in. thickness of metal, whilst the smaller ones are found to possess sufficient strength for their work with a thickness of ¼in. The poles now erected are the outcome of considerable experimenting on the part of the contractors and Messrs. James Russell and Sons, Wednesbury

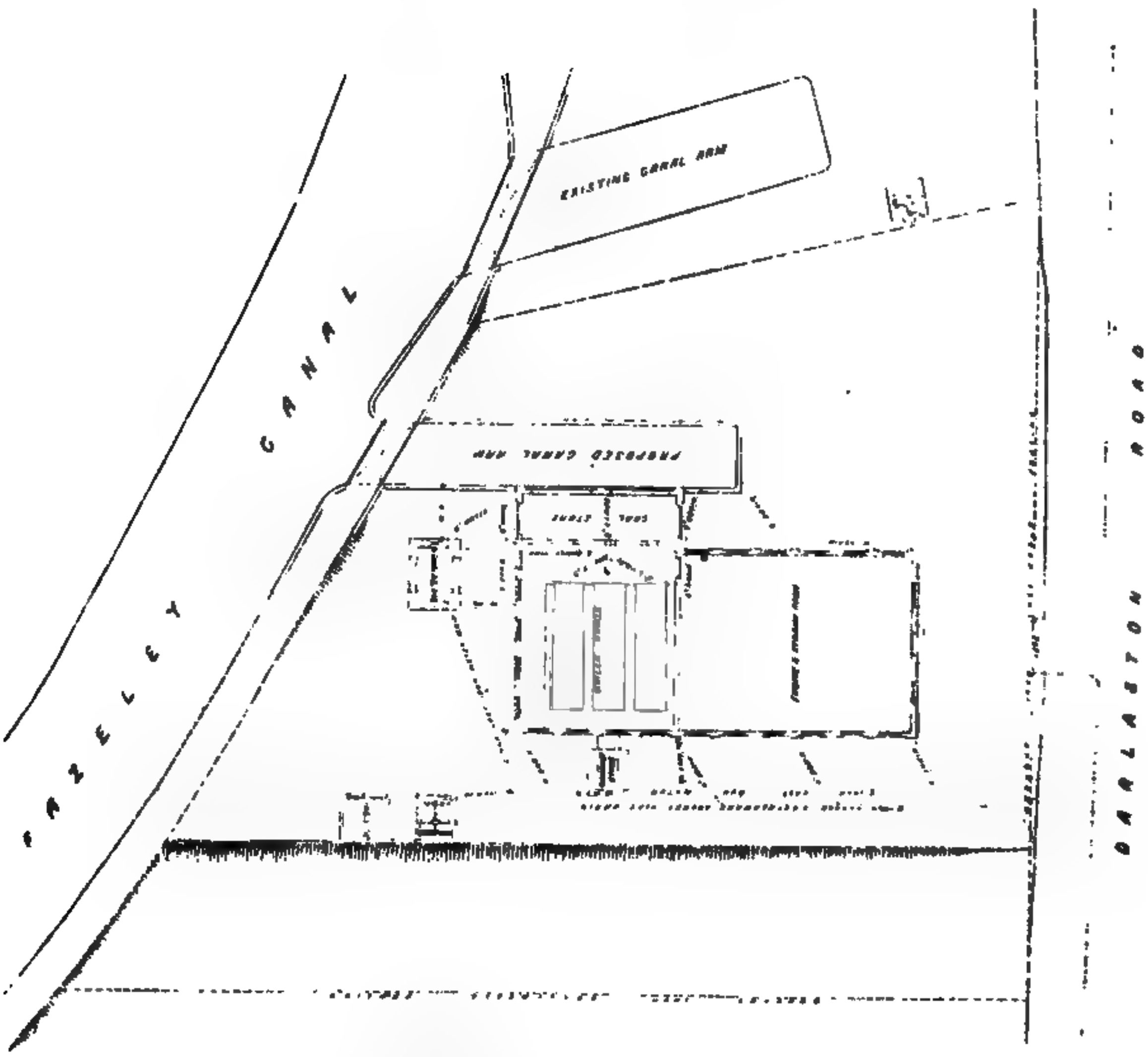
the firm which has made the greater part of the poles. Those first erected for trial were too heavy, and therefore expensive, whilst at the same time of cumbersome appearance. These faults, however, can hardly be alleged now against the poles finally chosen; their appearance is neat, while it is found in practice that they possess an ample reserve of strength to withstand any ordinary strain. It is doubtful even whether the force of a collision with



Plan and Sections of New Canal Arm alongside Coal Store.

runaway vehicles (the only serious possibility) would have any more effect upon the smallest-sized pole than the attack of Stephenson's hypothetical cow upon his locomotive. The 12in. poles measure over all a length of about 32ft.; of this amount a distance of 6ft. 4in. represents the part sunk into the ground below the pathway level. The smaller poles are nearly of the same height, but a less dis-





tance—5ft. 10in.—sunk into the ground suffices in their case, and the trolley wire is thus kept at pretty much the same average height above the roadway. This height may be taken at 21ft.

Each pole is practically composed of two separate parts or tubes. In the case of the 12in. size, the bottom portion *is of the same* diameter throughout—*i.e.*, 11in. internally—and measures in length 10ft. 10½in., of which, as stated, rather more than half is underground.

To anchor the bottom portion firmly to the ground, two heavy cast-iron base-plates are provided, one of which is fixed at the extreme end of the base, and the other about 5ft. higher—*i.e.*, about 16in. below the ground level. These base-plates are made in two halves, to fit round the tube, and are bolted together so as to firmly clamp the latter. In addition to this, they each rest upon a wrought-iron flanged collar, riveted to the tube at the points above named. The intermediate space between the plates—and, indeed, right up to the ground level—is filled in with concrete.

At a distance of 3ft. above the ground level, a wrought

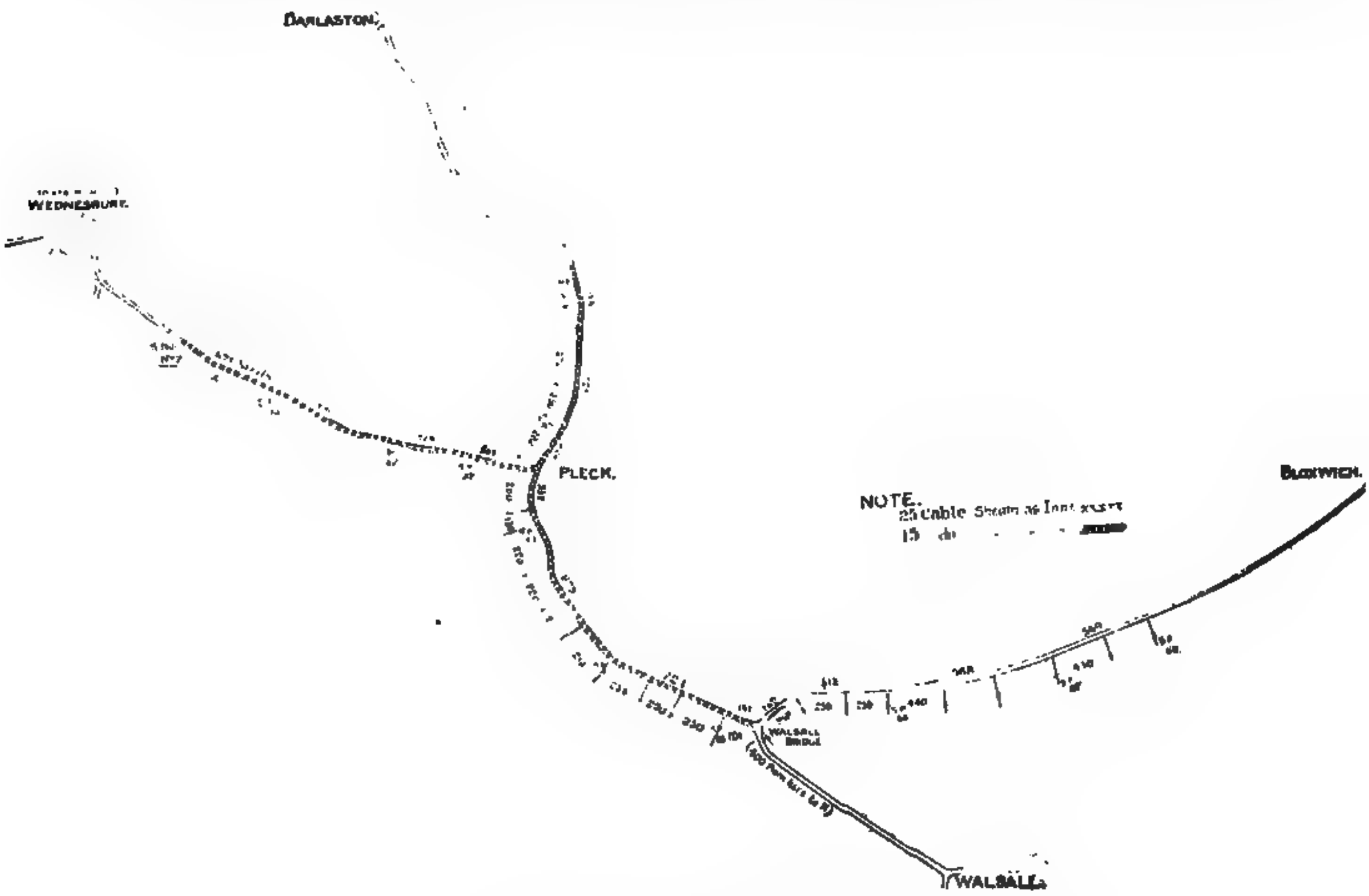
iron collar, measuring 2in. by $\frac{3}{8}$in., is riveted to the inside of the bottom tube in order to serve as a support for the base of the top tube. The latter has a length of 20ft. 5in., a cast-iron finial, measuring 12in. in length, being screwed into the top, which is, of course, plugged for its reception, the plug being welded in. This tube has a considerable taper, being 11in. at the base, whilst at the top it is only $5\frac{1}{4}$in., both dimensions being those of external diameter. Each one is fitted at the makers' works into the bottom tube whilst the latter is hot, so as to obtain a shrinking fit. A length of 15in. is considered sufficient overlap; but as a further means of ensuring a good solid joint a wrought-iron collar, 2in. by 1in., is shrunk on to the top of the bottom tube after the top tube has been fitted in. Above this collar is fixed an ornamental waist moulding by means of screws with countersunk heads.

The smaller types of poles—that is, the 6in. and 7in. sizes—do not require quite such a substantial foundation as the larger ones; and instead of two heavy cast-iron base-plates, a single one is found sufficient. This is made

upon the poles. At the tee end the arm tube measures $2\frac{3}{8}$in. external diameter; this is tapered down to $1\frac{1}{4}$in. at the outer or projecting end, into which, when plugged, a small cast-iron finial is finally screwed.

At the outer end of the arm tube a split tubular clip is fixed by means of a $\frac{1}{2}$in. bolt, passing through lugs or ears; from this clip is hung, below the arm, the insulator and trolley wire clamp, whilst the tightening bolt just referred to serves also to secure one end of a long wrought-iron strap, $\frac{3}{8}$in. by $1\frac{3}{16}$in., that passes to a similar split collar or clip fastened to the top of the pole, and serving as a guy to keep the arm or bracket in proper tension against the weight of itself and the trolley wire, etc. Insulating collars of indiarubber are inserted between each of these clips and the post or arm, as the case may be.

The trolley wire is of solid drawn copper, 312·5 mils in diameter. At the insulators or points of suspension it is firmly gripped by a metal strap bent upwards, and riveted to a double claw, which presses down upon the wire. The latter is therefore firmly held against end motion, and the



Map showing Arrangement of Feeders.

of wrought iron, is 2ft. 3in. square, and no thicker than $\frac{1}{4}$in. The centre part is pressed upwards, or buckled, to a depth of some $2\frac{1}{4}$in. To the bottom of each pole is riveted a wrought-iron collar, $1\frac{3}{8}$in. by $\frac{3}{8}$in., bent out between the rivets, to give four corners, or lugs. Through these are passed $\frac{3}{4}$in. bolts, which also pass through the base-plate, and are secured underneath by nuts. Other details of the foundation work may be gathered from the drawings given herewith.

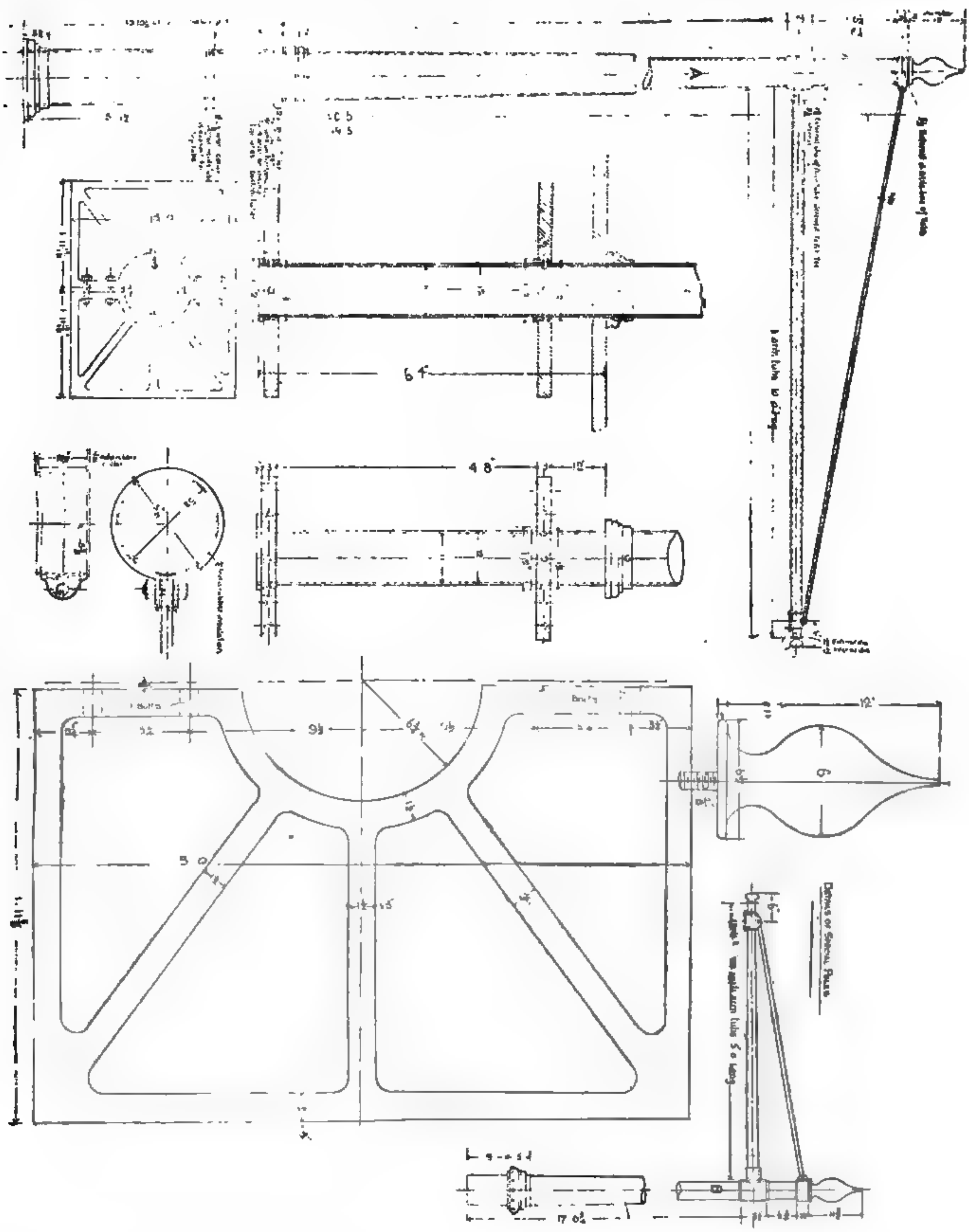
At an average height of some 21ft. above the roadway, as already stated, an arm or bracket extends from each pole over the roadway to support the insulator and trolley wire fastened thereto. The length of this arm varies, of course, with the distance of the rails from the sidewalk; in some cases it is not more than 2ft. 6in. long, in others it is 5ft., 7ft., 8ft., 9ft., and 10ft., the latter, of course, being required where the line is double, so that the trolley wire is branched on two insulators, both fixed, however, to the one arm. Each arm or bracket—all of which are made of steel tubes similarly to the poles—is fastened to the latter by being simply screwed into a tee firmly shrunk

compression of the clamp arrangement serves to give the wire a slight bend upwards, thus not only gripping it more tightly, but presenting a level surface underneath for the trolley wheel to press against, since the thickness of the metal strap fills up the gap otherwise left by bending the wire upwards. The clamp swings on a bolt secured by washer and pin to a metal fork screwed on a stud. The latter again is screwed into a flange-headed socket let into the insulator. The insulators are indeed prepared by the makers with this socket in position, and also with a brass cap on the top, having a turned-in lip round the lower circumference. The insulating material is thus moulded in between the socket for the stud and the brass protecting cap. The latter is cast with a long bearing at the top, through which passes a bolt secured by lock nuts to the fork of the split collar or tubular clamp, already spoken of as being fixed at the end of the pole arm or bracket. Details of this arrangement are given in the drawings now published.

Turning now to the trolley itself, it may be said that although usage allows the expression to be employed, yet the common idea conveyed by the word "trolley," is not

the required purpose of collecting current from the overhead wire. This wheel is grooved V-shaped, but with a circular base to the groove, in order to grip as much of the wire as possible. It is mounted in a fork, whose tops are curved slightly inwards so as nearly to touch the wheel flanges. Light springs are attached to the inside of the fork, pressing against the wheel and keeping it in position. A pin, or light spindle — on which the wheel runs — passes through the fork, being secured at one end by its own countersunk head, and at the other by a split pin. A capacious oil reservoir is very ingeniously placed under the wheel, with a tube and wick, or wiper, leading upwards so as to bear against the shoulder where the wheel hub butts upon the side of the fork, and thus supply plenty of lubricant.

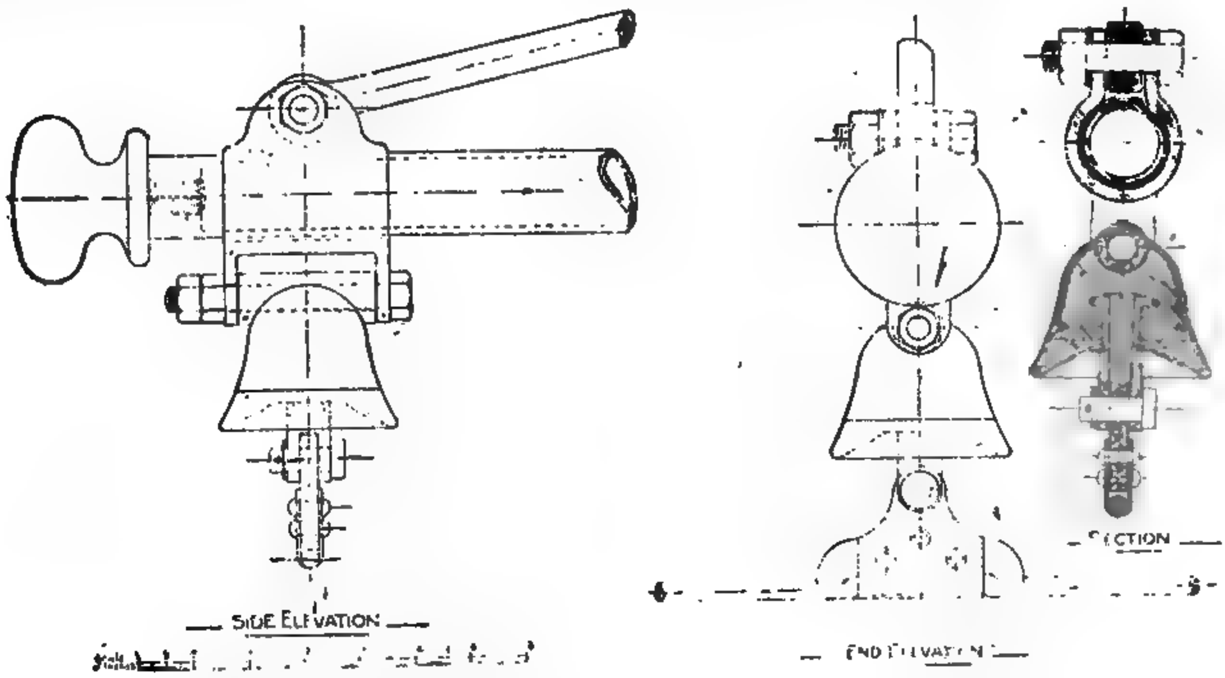
The chief novelty of the whole equipment may be said to lie in this greatly improved type of trolley, and also in the trolley-pole fixture—shortly to be described. All those who are interested in, or who have studied overhead conductor electric traction methods, are painfully aware of two facts that have usually proved obstacles of no little importance to the speedy adoption of this otherwise excel lent system. There are, in the first place, incessant variations in the distance between the rails and the line of posts along the footpath or side of the roadway; and, second, the question of satisfactorily taking the



Details of Street Pole—12in. Diameter at Base.

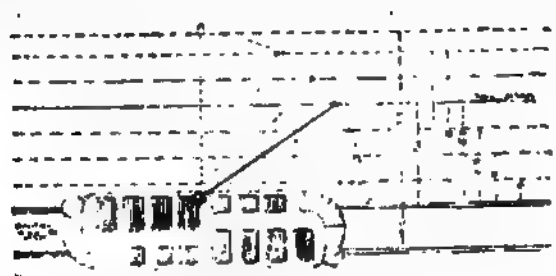
Details of Special Pole.

trolley wire round a curve almost always implies a multitude of guy wires or strainers, which at best only convert the straight wire into a series of chords.

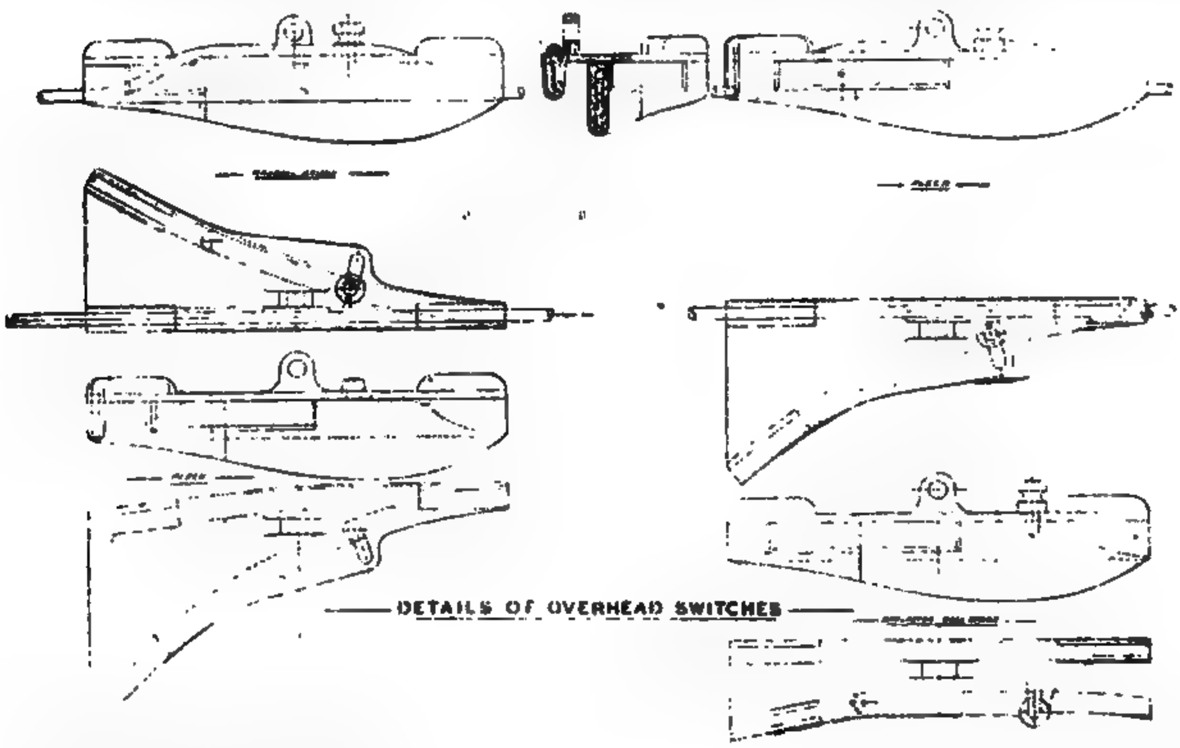


Details of Insulation and Trolley Wire Clamp.

By the arrangement now to be described—chiefly, if not altogether, due to the ingenuity of Mr. A. Dickinson,



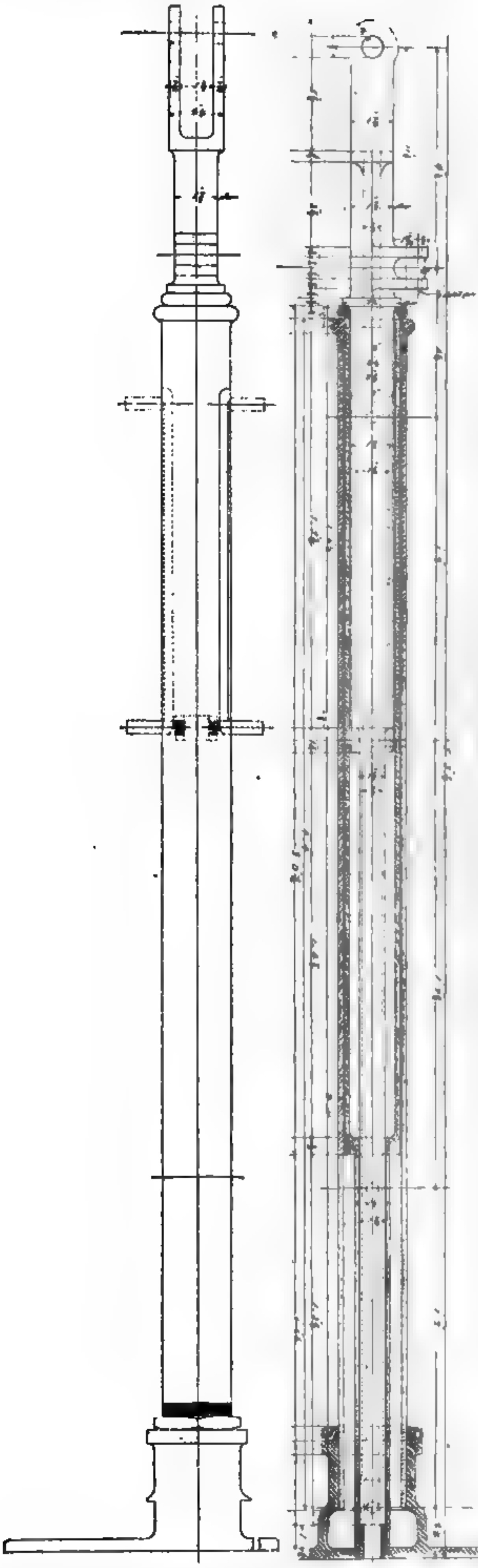
Plan showing Range of Side Movement in Trolley Pole.



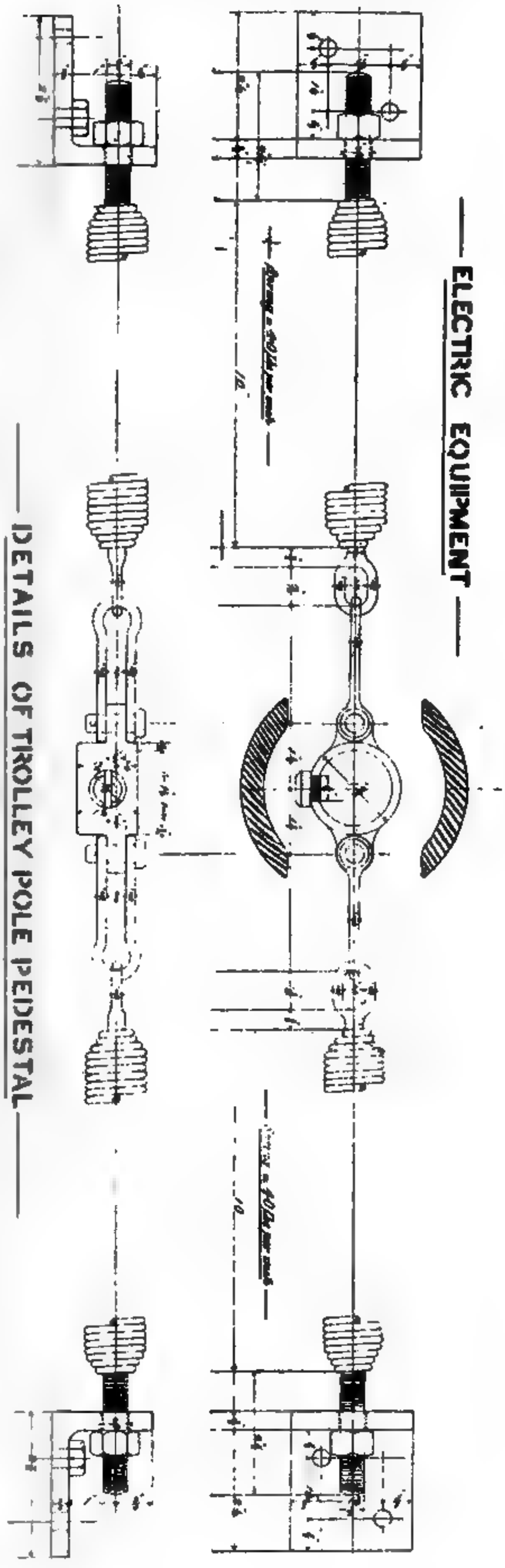
the general manager of this line—no trouble is experienced from either of these sources. The improvement by which the difficulty is overcome simply involves the application of a universal joint. This is done by allowing the trolley pole to swivel in its socket on the top of the car, and the trolley itself also to turn in the socket fixed at the end of the trolley pole and holding the shaft of the fork in which it runs.

When, therefore, the car is 10ft. or 12ft. from the footpath, the trolley pole extends from the side almost at right angles, whilst the trolley itself—keeping always parallel with the wire—is at right angles to the trolley pole. Between this extreme and that in which the trolley pole is parallel with the car—*i.e.*, with an angular motion of 90deg.—there is, of course, ample scope for meeting all conditions of distance from the line of poles, and practically, also, of variation in curvature of the line. The advantages of thus doing away with a large number of guy wires, and also avoiding an excessive length of pole bracket, cannot be too strongly noted; inasmuch as these improvements appear practically to overcome every objection due to prejudice that a British public might bring

ard. The trolley fork is provided with a round shaft, or k, which fits into a socket on the end of the trolley over any desired angle, but prevents it from jumping upwards or being torn out of the socket.



DETAILS OF TROLLEY POLE PEDESTAL

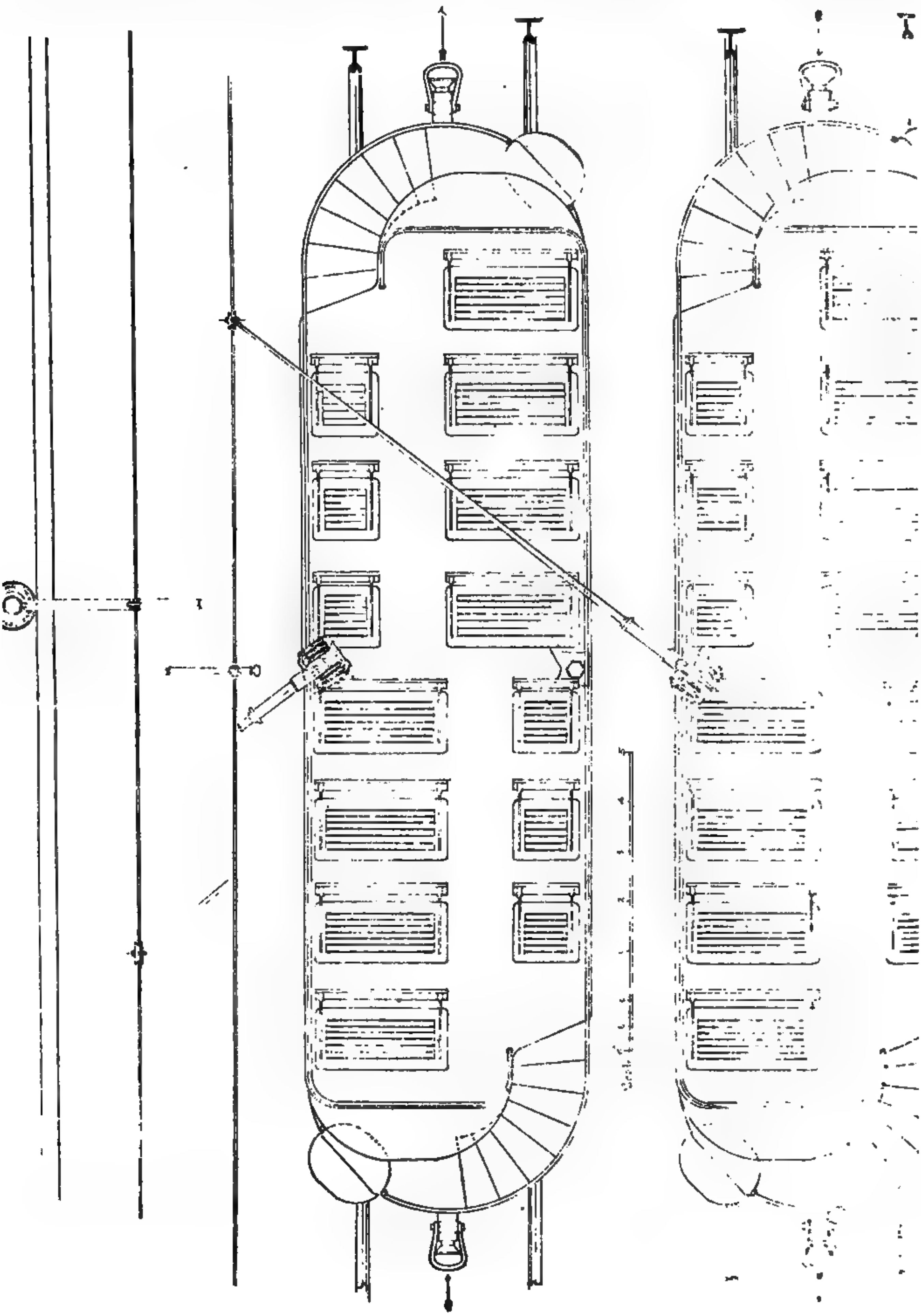


ELECTRIC EQUIPMENT

; a circular grooved keyway is cut round the shaft, a round pin passed through a hole in the socket so as e in the keyway. This allows the shaft to turn freely

The trolley pole is of an extremely simple form. It consists of a stout tube about 3ft. in length, let into and capable of swivelling in a larger tube some 5ft. in height,

mounted upon the top of the car at one side. At the upper end of the shorter tube is pivoted the base of the trolley



pole proper, having an elbow frame joined to it; from the *ter end of the latter strong* spiral springs are secured to the short tube, thus giving the necessary tension upwards the trolley pole and trolley itself against the overhead wir

The greater part of the line is, of course, single. the turn-outs or crossovers, where the line is doubled, tl

street pole brackets are made extra long—up to, say, 10ft. spread—and a double arrangement of insulators provided. The trolley wire junctions themselves are of simple form, and require no comment. The entire question, indeed, of cars passing one another merely implies that the trolley of the car on the near side of the road leaves the main trolley wire for a supplementary one, which is suspended from insulators placed on the bracket arms nearer to the footpath, whilst the other car maintains its trolley upon the main wire. Its trolley pole, however, in order to keep the trolley in position, must cross right over the first car, but the height is amply sufficient to clear everything, and passengers will have no reason to fear that the pole may knock their hats off on a 6ft. clearance above the top of the seats outside.

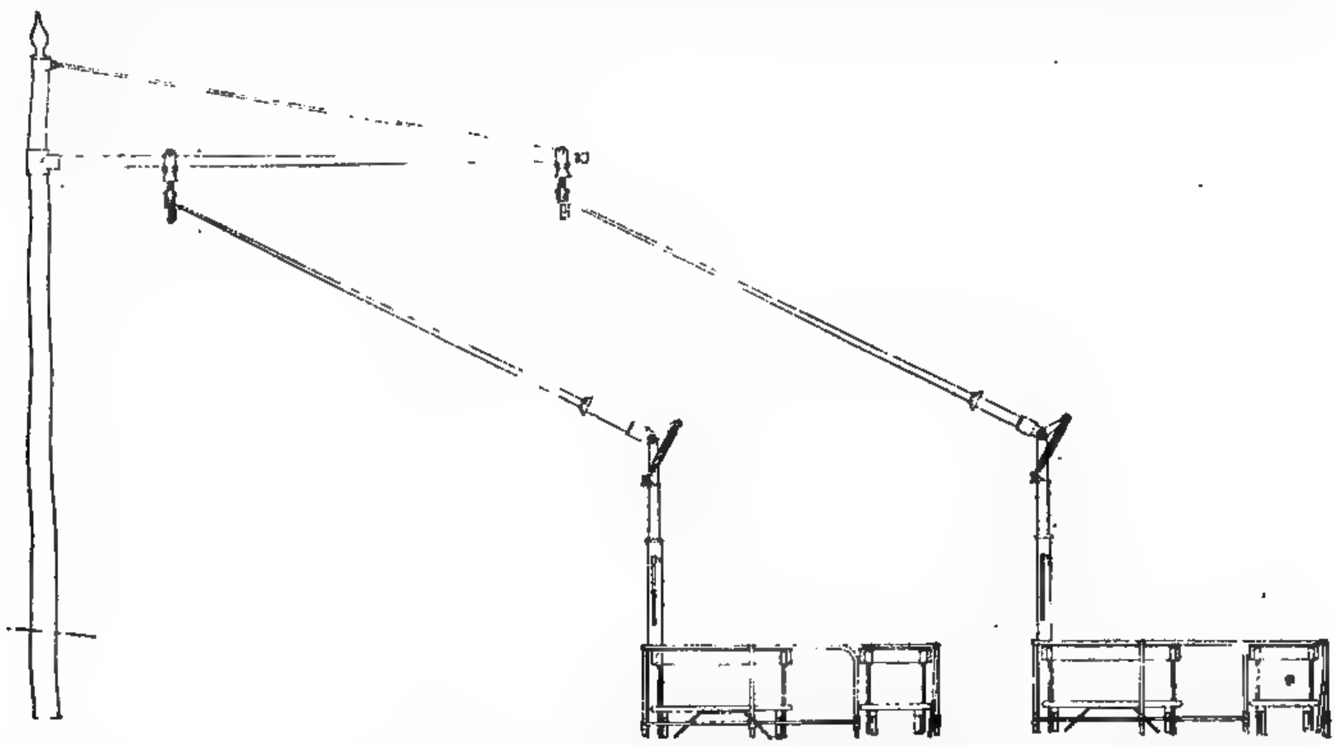
The cars to be employed for this new electric service on the South Staffordshire Company's lines have all been specially built for the purpose by Messrs. Brown, Marshall, and Co., Limited, Saltley, Birmingham, and in this respect the tramway company has doubtless followed a wise course by employing absolutely new rolling-stock rather than take the questionable course of adapting that already in use. It is seldom that satisfaction follows the putting, metaphorically speaking, of new wine into old bottles; although in the case of electric traction it is a comparatively easy and economical matter to convert horse or steam cars into rolling-stock to be driven by electric motors—whether on the accumulator or the conductor system. Anyway, it shows commendable enterprise and a high degree of confidence in the success of the scheme that the tramway company should have equipped the line to be electrically operated with entirely new cars upon which may be fitted more conveniently the latest and best appliances.

If the endeavour had been made to adapt or alter the cars previously used for steam traction on this line, the result would probably have proved unsatisfactory and expensive, owing to consequent modifications in the design throughout. Much heavier motors would have been necessary, the overhead construction of greater capacity, the central station and generating plant of larger output—all this apart from alterations to the cars themselves—although probably the receipts would be little, if any, more. This point is emphasised because in many cases it is pointed out that great economy in capital expenditure should result from simply altering the ordinary cars when electric traction is adopted for any line. This economy is not always existent, though in many cases it may be found: more often it is balanced, and even outweighed, by increased working expenses.

The new cars, which are of one type and design, are double-decked, like those previously used on this line with steam locomotives, but the awning is conspicuous by its absence. Probably no one will miss it; little or no satisfactory protection from the weather is obtained in this way, whilst the extra weight and possibly increased windage must tell against its use. Seating accommodation is provided for 40 passengers—18 inside and 22 on the top. The outside seats are of the "common or garden" form, with reversible backs, and the usual staircase is provided at each end. The length of each car over all measures 22ft., whilst the clear height, apart from the trolley-pole standard, is 12ft. from rail level to top of handrail. A single truck is used underneath the car frame, with 6ft. wheel centres, the amount of overhang at each end being also about the same length (6ft.). The wheels are of cast steel, with mild-steel axles and rolled-steel tires shrunk on; in diameter they measure 2ft. 9in.

Ordinary and emergency hand brakes are provided. These act upon all the wheels, and may be applied from either end of the car by a hand-wheel.

The weight of each car, empty, is stated to be less than $4\frac{1}{2}$ tons without the motors, or, say, six tons including the two motors. Fully loaded with passengers, etc., the total weight may be taken at $8\frac{1}{4}$ tons inclusive. The car interiors are, of course, lighted by electricity, though special arrangements, as on the City and South London line, will doubtless have to be made for this purpose, owing to fluctuations of pressure in the main circuit.



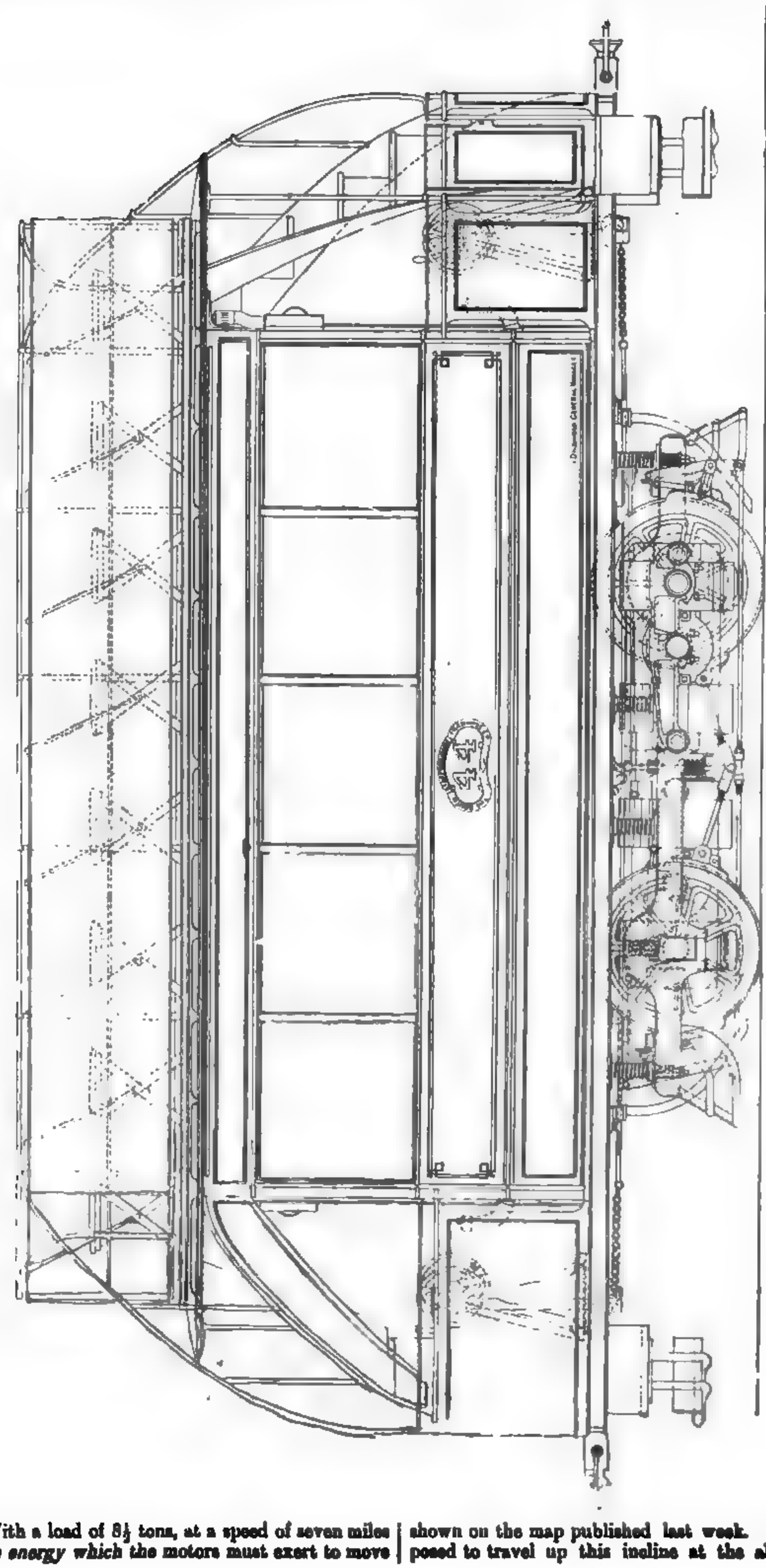
nd Elevation, Showing Cars Passing, with Range of Side Movement of Trolley Poles.

The necessary switch and brake handles are fitted to the car in duplicate—one set at each end—so that the driver, or "motorneer," in reversing the car for a return journey has nothing to do but pass from one end to the other.

Two motors are employed for each car, and the switch arrangements not only allow these to be coupled in series or parallel for starting and when under way, but also serve to vary the field magnet circuits and thus enable the speed to be regulated over a wide range. Single helical gear is employed, with cast-steel wheels 1ft. 9in. diameter. The pinions measure 6in. in diameter. At a speed of seven miles per hour the car axles go round about 70 times per minute, so that the motor speed is not more than 250 revolutions per minute. The motor frames are suspended in a similar fashion to that now usually adopted—that is, with bearings at one end upon the car axle, whilst the other end is hung by powerful springs from a beam running across the centre of the car frame.

Taking an average amount of 30lb. per ton as " tractive force required for an ordinary tramcar to overcome

the line-resistance, it is interesting to note the power necessary on this line to move the cars, apart from questions of gradient. With a load of 8½ tons, at a speed of seven miles [an] hour, the energy which the motors must exert to move each car on the level is approximately 5 h.p. The steepest gradient on the line is a short length of 1 in 16, as shown on the map published last week. If a car be supposed to travel up this incline at the above speed, fully



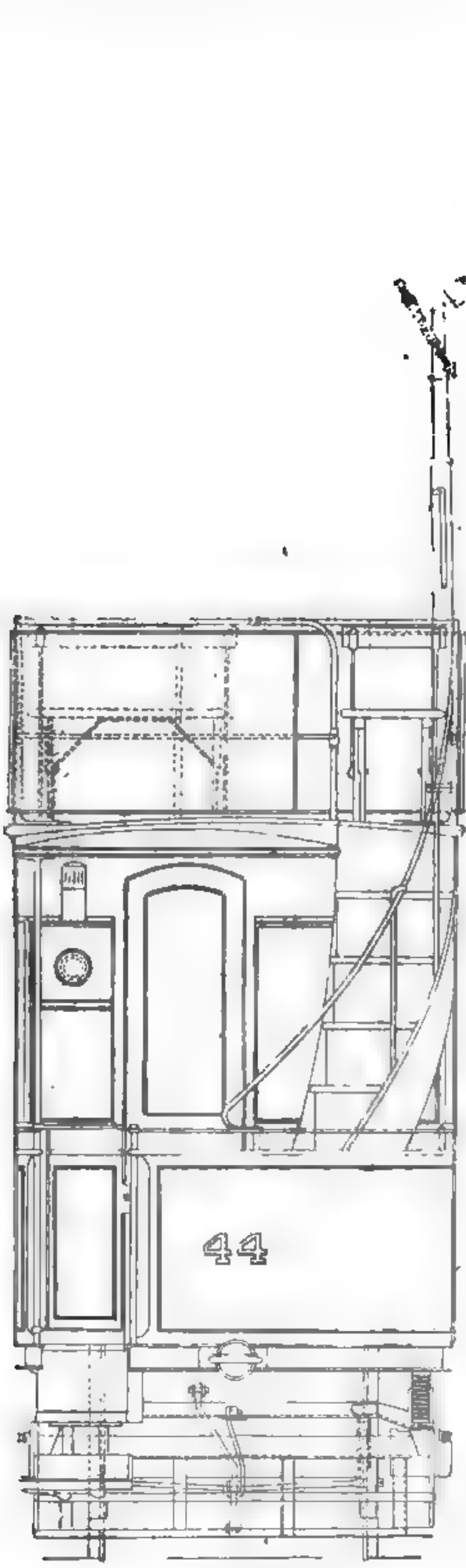
SIDE ELEVATION

View showing Brake and Motor Gear

loaded, the motors would be called upon to exert no less than 22 h.p. in addition, or a total of 27 h.p. As a matter of fact, the same speed is, of course, not kept up when ascending a gradient as on the level; but the figures given serve very well to emphasise the great range of power required for traction effort, not only in starting the cars, but also in overcoming the influence of gravity.

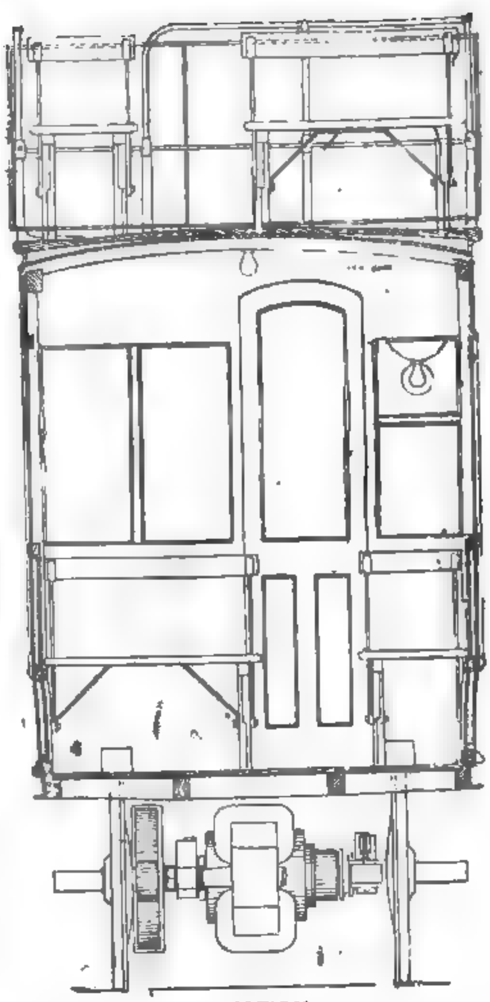
whole joint being then tinned. The rivets pass, with a drive fit, through holes drilled in the rail ends, and are then closed over with heavy hand hammers.

The same rails used for steam traction will serve for the electric cars; the section is shown in an accompanying illustration. They have been put down in 30ft. lengths, and weigh 75lb. per yard, being 6in. in depth. Flat iron



ENQ ELEVATION

Car with Trolley Pole and Trolley.



SECTION

End View of Car Showing One Motor and Gear.

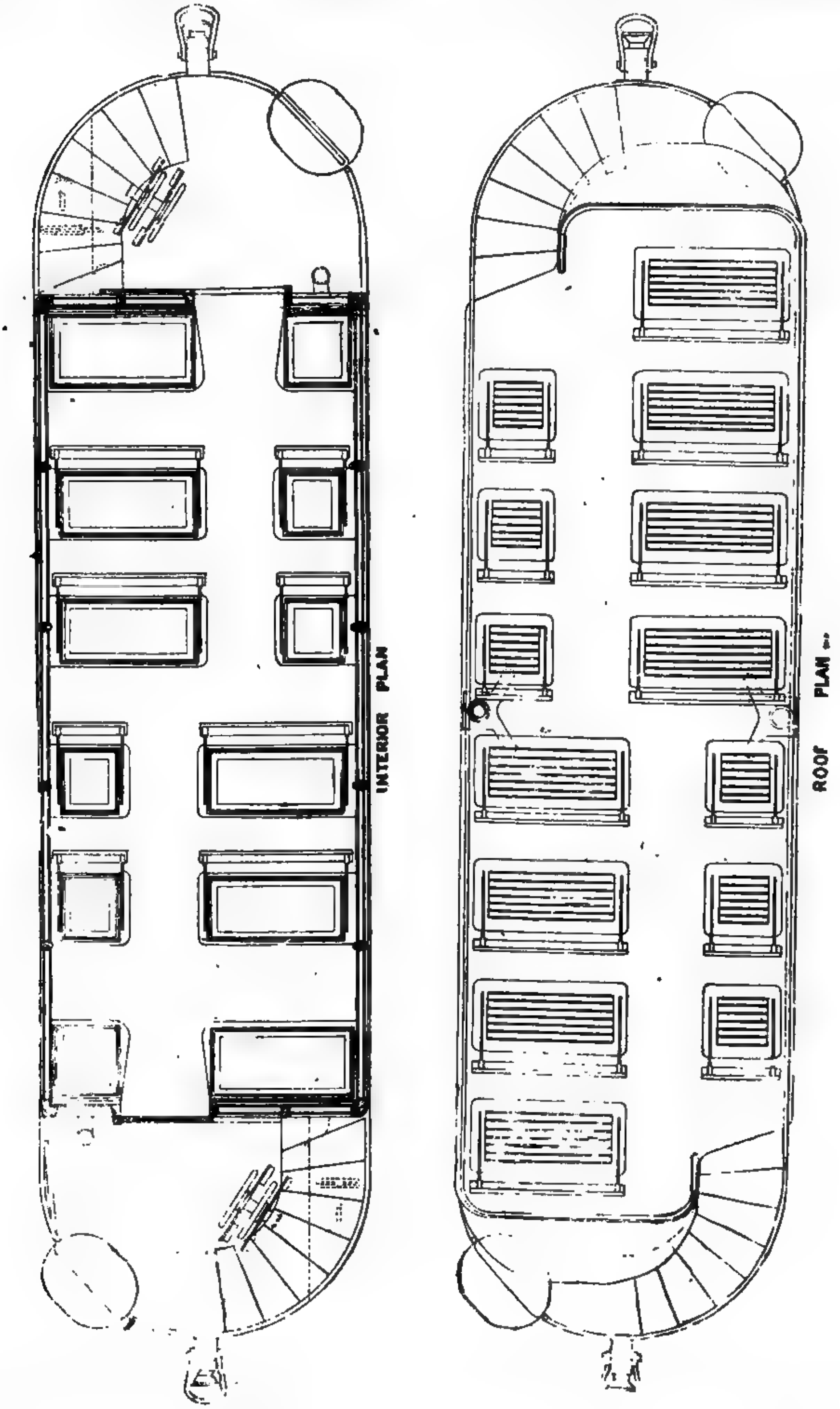
There are not many details to be given of especial interest in connection with the line or permanent way itself. Considerable expense has, of course, been necessary in putting down rail bonds in order to secure as efficient an earth return as possible, but apart from this no structural changes have been required for the new system of working. The rail bonds consist of stout copper wire in 2ft. lengths; to each end of one length is soldered a soft iron rivet, the

ties, 1½in. by ½in., rounded and screwed ¾in. at each end, are fixed every 8ft., and serve to keep the gauge true. The rail bed or foundation is, of course, built of concrete in the usual style, one heavy 6in. layer sufficing for the purpose.

Every precaution has been taken by the contractors to secure efficient and reliable work; and they are to be congratulated upon the results so far shown. As an instance of the care taken to prevent stoppage of traffic, it may be

nentioned that the whole system of overhead conductors s arranged in short sections, so that if anything should go

The whole of the electrical and station equipment has been in the hands of the Electric Construction Corporation,

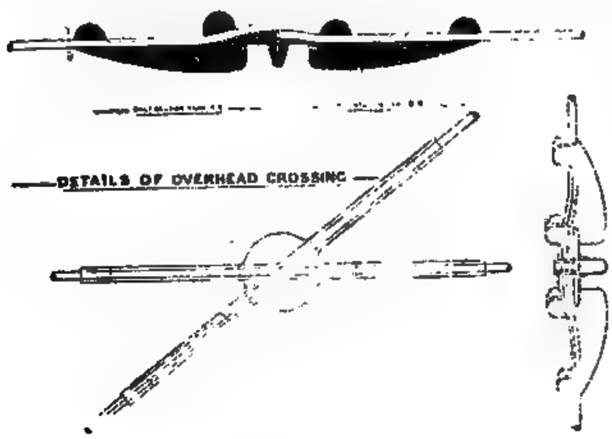


The New Electric Tramcars on the South Staffordshire Tramway.

wrong with one of these, it may at once be cut off whilst repairs are being effected, without at the same time interfering with the traffic elsewhere.

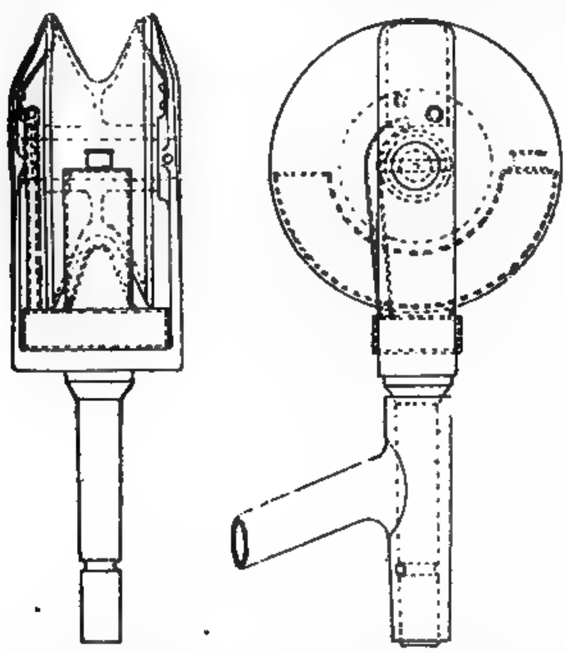
whose energetic manager, Mr. T. Parker, has found this line a splendid source of opportunities for exercising his well-known and able ingenuity in overcoming obstacles.

The Corporation, besides supplying all the electrical plant, has entered into a contract with the Tramway Company to work the system for five years at a fixed mileage rate,



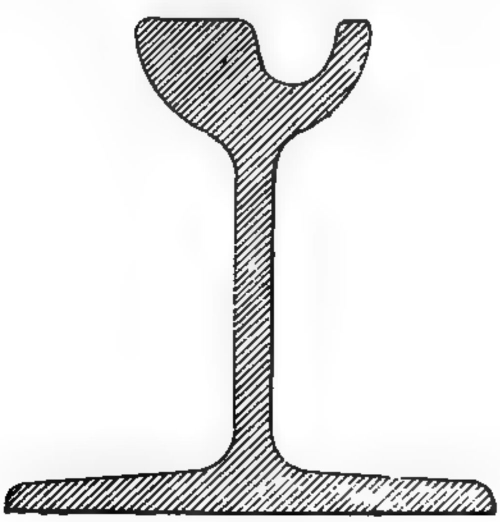
Overhead Crossing.

inclusive of maintenance. Mr. E. Parker has represented the Construction Corporation on the contract as resident engineer.



The Trolley.

Not the smallest part of the credit, however, by any means is due to Mr. Alfred Dickinson, C.E., the Tramway



Section of Tram Rail.

Company's general manager, who has provided the designs, plans, and specifications throughout, and superintended the conversion of the concern from one system to the other. Indeed, the special features which have been already indicated as forming the essence of novelty in this electric system are, it is stated, almost entirely due to Mr. Dickinson, and he must therefore be credited with showing tramway engineers in general how they may most advantageously introduce electric traction on their lines without trespassing in any possible degree upon the well-known prejudices of the British public.

ELECTRO-HARMONIC SOCIETY.

The next concert of the above society will be a ladies night, and will take place on Friday, November 25, at the St. James's Hall Restaurant (Banquet-room), Regent-street, W., at eight o'clock. Artistes: The Queen Vocal Quartette, Miss Mina Rees, Miss Mary Hutton, Miss Amy Sargent, Miss Lucie Johnstone; violoncello, Mr. Clement Hann; pianist, Mr. Alfred E. Izard; humourist, Mr. F. Upton; musical directors, Mr. T. E. Gatehouse and Mr. Alfred Izard. A Bechstein concert grand pianoforte will be used:

PROGRAMME—Part I.

Quartette .... "Legends" .... Mohrling
Queen Vocal Quartette.

Song .... "Il Bacio" .... Arditi
Miss Mina Rees.

Violoncello solo .... (a) "Reverie" .... —
(b) "Tarantelle" .... Poppin
Mr. Clement Hann.

Quartette .... "The Banks of Allan Water" Specially arranged
Queen Vocal Quartette.

Pianoforte solo .... "Polonaise" .... Lizt
Mr. Alfred Izard.

Song .... "Voices in the Heart" .... Slaughter
Miss Mary Hutton.

Quartette .... "The Old Folks at Home," Specially arranged.
Queen Vocal Quartette.

Sensation novel .... "The Tragedy" .... Upton.
Mr. F. Upton.

PART II.

Duet (violoncello and pianoforte) "Variations, Op. 17" .... Mendelssohn.
Mr. Clement Hann and Mr. Alfred Izard.

Song .... "One Word" .... Pinsuti.
Miss Amy Sargent.

Duet .... "Friendship" .... Marziale
Miss Mary Hutton and Miss Lucie Johnstone.

Violoncello solo .... (a) "Intermezzo" .... Mascagni
(b) "La Fileuse" .... Duhkler
Mr. Clement Hann.

Plantation song .... "Sweetheart Sue" .... H. Talbot
Queen Vocal Quartette.

Song .... "Beyond the World" .... H. Talbot
Miss Lucie Johnstone.

Valse .... "Spring Song" .... Worth
Queen Vocal Quartette.

Sensation novel "A Grandfather in Spite of Himself" ...... Upton
Mr. F. Upton.

THE INSTITUTION.

SIR,—If the Council of the Institute is to be changed so as to more nearly represent the actual membership, may I suggest that provincial members should have two or three seats? I am well aware of the difficulties attending the proper service of a provincial member of Council, and that the actual work of the Institution must be done by local members; but nearly all provincial members come to town more or less frequently during the season, and it would not usually be difficult for them to attend some meetings of the Council. Probably, too, the consciousness of having a duty to perform would make most men come up more often. If such a course was adopted, and we in the provinces were represented by a few strong members who would not mind taking a little trouble on behalf of their constituents, I imagine that the great complaint raised in my article—that of the persistent neglect of everyone not resident in London—would soon disappear.—Yours, etc.,

SYDNEY F. W[illegible]

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CONTENTS.

TO CORRESPONDENTS.

SPECIFICATIONS.

It is becoming necessary to direct close attention, not only to the successes of electrical engineers but also to their failings. For a time people have to be satisfied during the development of a new industry with the results of imperfect knowledge, but as time passes onwards they expect improvement. In the question of proper specifications we fear that on the whole there is no improvement, that the matter and method of the clauses cannot be for a moment considered satisfactory. The fault is one that might have been, and indeed was foreseen. Even yet the general public make no distinction between an electrical engineer and an electrician. They go to the latter when they ought to go to the former. Experience will open their eyes to the difference, but then experience is usually gained too late. We are on the eve of many central stations being designed and built. The course to be pursued, which we have strenuously advocated, and which we believe is the only good one, is for the local authority to employ the *best* available consulting engineer just as it would for waterworks or sewage schemes. Instead of doing this, however, too many are under the glamour of a name. To them the man who calls himself an electrical engineer is assumed to be one, and a competent one. Terms are asked for, and while *the* competent man requires a fee commensurate with his knowledge and abilities, the incompetent man asks for what he thinks will tempt the querist to employ him, and is frequently employed accordingly. That is a fatal mistake. The incompetent man is filled to repletion with a jargon of technical terms—especially electric—which have little or no bearing upon the matter in hand. He has to design a central station, and not talk to a class of boys. The electrical engineer must, if competent, be a good mechanical engineer. The central station, if it is to work properly and be maintained economically, must be properly equipped both mechanically and electrically; in fact, we imagine the more important part economically is the mechanical. Still, there is hardly a detail either mechanical or electrical which is not essential to economical maintenance, and which, therefore, if ill-designed has a bad effect upon the whole installation. These considerations mean that the designer should have a thorough knowledge of each branch of the work; should carefully design each detail so that no weak point appeared. This brings us to the drafting of the specification. In the great majority of instances clauses now appear that this or that part of the apparatus is to be supplied to the satisfaction of the engineer. Any clause of that kind is a proof positive that the specification is from the hands of an incompetent man. The materials required, the apparatus wanted, in every detail should be clearly and specifically described. Nothing should be left to chance or to the contractor's whim. We have pointed out again and again that tenders sent in by contractors who each specifies his own particular system cannot be compared satisfactorily by any human being: there is no common ground of comparison, and the user is in the same position as the man who goes to half-a-dozen builders and says "What

will you build me a house for after your own design? The man, in the first place, has no proof that the design will be appropriate to the position or for his requirements, especially if he gives his order to the tender which appears lowest. We say appears advisedly, because it often happens that the tender which appears lowest, in reality in the long run is far from being so. But there is justly as much adverse criticism from the contractor's side at these badly-drawn specifications as there is from our point of view. When the decision is left to the contractor, if he has a reputation he immediately puts aside all ideas of cheap and nasty, and estimates for proper work and excellent materials; if, on the other hand, he has no reputation, and is merely running after work at any price, he estimates for the cheapest materials regardless of how long they will last without costly repairs. The maintenance is not his look out. The designer knows or cares nothing about the future, therefore the tendency is to legislate for the present only. Again, there may be various apparatuses fulfilling the same or similar functions. The designer who specifies at random, or leaves it to the contractor, probably does not know much about the apparatus; hence one contractor may estimate for the proper apparatus, another for the cheapest, trusting to the ignorance of the engineer to pass the estimate. A few hundred pounds of difference is soon made up in such ways, and we are bound to state that the best contractors are and must be the greatest sufferers from badly-drawn specifications.

SOUTH STAFFORDSHIRE TRAMWAYS.

There are many reasons why we should direct attention to the South Staffordshire electrical tramway system. In the first place, it is the first English attempt to instal an overhead system. We are, of course, well aware of what has been done at Leeds, but that work was due to the enterprise and energy of an American house. In the second place, the design of the South Staffordshire system is no mere plagiarism of the overhead system so largely employed in America, but is in numberless points original. Generally, when an overhead system is used, poles are erected on both sides of the street with a trolley wire in the centre, but Mr. Dickinson has designed this with only one set of poles on one side of the road, which enables passengers to be carried on as well as in the cars. The technical details are, however, set forth elsewhere, and we think all who read them will agree with General Hutchinson in congratulating Mr. Dickinson and Mr. Parker for the successful manner in which they seem to have designed and carried out the whole of the work. As would be gathered from the plan of the district given in our last issue, its centre is Walsall. The whole of the South Staffordshire system is not equipped with electrical plant. The company has some twenty-three miles of line, and has long used steam traction, which, however, was not liked by the inhabitants, nor found cheap enough for the company. Hence the value of electricity was examined, and before consent was given for its use, the authorities of the district made exhaustive enquiries as to its suitability. Mr. F. Brown the electrical engineer to the Walsall Corporation went to America and reported on the electrical lines there. Reference to this report will be found in our issues of July 17th and 24th last year. A deputation of the Council visited Leeds to examine for themselves. Mr. Dickinson, no doubt to allay criticisms, suggested the possibility of using one set of poles only on one side through the streets, and has, as we have said, very ingeniously carried this out. The consent was given, and a start was made to equip about nine miles of line. The district the new system runs through is essentially a manufacturing one, and includes Walsall, Darlaston, Wednesbury, and Bloxwich. The population of Darlaston is 15,000. The principal articles made here are bolts and nuts, all kinds of screws, railway fastenings and general ironwork, roofs, bridges and girders, all kinds of wrought and cast ironwork, shoe tips, files, latches, wire gauges, and gunlocks. There are also malt kilns and brick-fields, and several extensive ironstone and coal pits, with an abundant supply of the valuable ore known as "blue flats." Walsall, which includes Bloxwich, is a municipal, parliamentary, and county borough, with a population of 72,000. Coal mines, quarries of limestone, ironstone and clay pits, are numerous. Among the manufactures for which it is noted may be enumerated saddlers' and coach ironmongery, buckles, chains, curbs, bits, spurs and stirrups with plated and other mountings, bridles, saddles, harness collars, and all the necessary trappings for horses and carriages; also locks, bolts, keys, pulleys, brushes, and spectacles. There are also a number of brass and iron foundries, iron, galvanised iron, and iron-tube works, several corn mills and tanneries, besides establishments for the currying, dyeing, and polishing of hides for the staple commodity of harnessware. Walsall is also known far and wide as the town in which "Sister Dora," the devoted nurse of sick folk, lived and died, and whose beautiful statue adorns the open square in the centre of the town. It is also not without historical interest. Queen Elizabeth, in one of her tours, affixed the Royal seal and signature at Walsall, or, as some say, whilst she was staying at the Manor House of Bescot on July 13 in the twenty-eighth year of her reign, to a deed preserved in the archives of the Corporation granting a deed of land to the town. In 1643 Henrietta Maria, Queen of Charles I., remained here for a short time, and is said to have stayed at The White Hart hostelry previous to joining the King at Edgehill.

Wednesbury, popularly known as Wedgebury, is a municipal and parliamentary borough and market town of considerable antiquity. The population of the parish in 1881 was 24,566. Its manufactures are numerous and important, the principal being rails, boiler-plates, bar iron, Bessemer steel, Siemens-Martin steel, railway carriage axles, general iron-work for railways, gas, water, and steam tubes, spades, shovels, and edge tools, gunlocks, coach springs, hinges, bolts and nuts, and wrought iron of every description. There are also stoneware potteries. An abundance of coal is found here, as well as iron ore, limestone, clay (both potter's and brick), and a kind of coal which, from the intense

heat it gives out, is admirably adapted for the forge. From this it will be seen that the traffic must necessarily be considerable, and, in fact, the company carries annually about four million passengers, a large proportion of which travel on that portion now to be served electrically. The Board of Trade inspection by Major-General Hutchinson and Major Cardew last Saturday was a great success, and led to the congratulations of General Hutchinson to the engineers for having brought the installation to such a successful issue.

INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 17.

The President, Prof. Ayrton, F.R.S., in the chair.

The following candidates were in due course balloted for and elected members of the Institution:

Foreign Members.—C. E. L. Brown, Baden, Switzerland; M. A. van der Sprong, assistant inspector, Dutch Indian Government Telegraphs, Batavia.

Associates.—Harold A. Clegg, 9, South parade, Manchester; William Corkhill, care of Messrs. Turner, Morrison, and Co., Asiatic Steam Navigation Company, Calcutta, India; Edward Henry Draper, Eastern Telegraph Company, 50, Old Broad street, E.C.; Edward Somerset Eccles, Tower House, The Hoe, Plymouth; Arthur H. M. Francis, 16, Fleet street, Dublin; Charles Jones, 42, Waterloo road North, Wolverhampton; Francis Hastings Medhurst, 2, Sidney street, Cambridge; Thomas Oddy, River street, Rochdale; Edward T. Parker, Newbridge House, Wolverhampton; H. Faraday Proctor, Moor View, Newcastle-on-Tyne; William Sillery, Wrexham; John Edwin Teague, Providence Wharf, Vauxhall, S.E.; Howard B. Trotter, 176, Adelaide road, N.W.; Archibald Wilson, 18, Warriston crescent, Edinburgh; Herbert Wooler, 34, Hall lane, Farnworth, near Bolton.

Students.—John George Barchell, Meadowhurst, Woodside lane, North Finchley; Frank Farley, The Law Courts Branch Bank of England, E.C.; Frederic Digby Latimer, 130, [illegible] street, E.C.; Hugh Berno Player, "The Wern," Ystalyfera; Charles Henry Stobart, St. Augustine's Vicarage, Bermondsey; Charles Barnard Wigg, 18, De Crespigny park, Denmark hill, S.E.

The discussion on Mr. Swinburne's paper, "The Problems of Commercial Electrolysis," was then continued by Mr. **Addenbrooke**, who stated that for the last two years he had devoted a great deal of time to the alloys and utilisation of aluminium. He agreed with Mr. Swinburne. The companies keep their processes secret as far as possible, and the demand is greater than the supply. There are [illegible] of processes to supersede the electrolytic processes. He thought that within 25 years aluminium would be as cheap as copper, and from its electrical properties it should be should be largely used in electrical work, such as for tramways. It would be well to watch the course of experiments.

Mr. Lloyd referred to the great interest of the paper, and added to Mr. Swinburne's list the work of electroplating. Cobalt, as stated by Prof. S. Thompson, is deposited in an easy manner, but to the speaker the greatest interest was in the deposition of alloys. This was a distinct advance, especially the deposition of silver alloys. By using alloys in Sheffield instead of silver, he calculated nearly £5,000 per year would be saved, in fact, more because of indirect savings. He called attention to samples of alloy of silver and cadmium. The latter is small in quantity, but the metal is improved, and it is difficult to find any difference in colour from pure silver. In depositing simple metals there was little for the electrician to do, but the secondary actions with alloys were very interesting and need careful attention. A sample of brass deposit, as also of palladium, was noticed. The latter was not oxidisable, and the plated material would stand a very high temperature without peeling. The palladium plating had been tried with the arc and stood successfully.

Mr Bevan referred to observations of Mr. Faulkner relating to chlorates, and said that the magnesium chlorate was found if the conditions were favourable and not otherwise. In connection with the paper, Mr. Swinburne takes the cost of power at ½d. per kilowatt, and the speaker thought this was a satisfactory figure, and not, as some speakers thought, too low. It was hardly fair to compare the price of oxygen obtained by oxygen [illegible] electrolytically and by the Brin process. In electrolysing sodium chloride from 4 volts to 4½ volts was an economical pressure. The strength of solution was important, and the speaker did not agree with Mr. Swinburne's comparison with those in the evaporation of the caustic liquor. He agreed with Mr. Swinburne as to the anodes, that Greenwood's anode would stand the wear and tear. He disagreed with Mr. Swinburne as to the influence of the salt upon the caustic soda. The results obtained in his experiments were recorded in the *Journal* of the Society of Chemical Industry.

Mr Trotter thought that some of Mr. Swinburne's examples were rather of electro-chemistry than electrolysis, and though he could not suggest a theory for electric tanning accepted as most probable that of Chastaing. (Practical tanners say that electric tanning is pure and unmitigated nonsense, and the failure of all [illegible] anywhere seems to point to this conclusion as a [illegible] one.—*Ed. E.E.*) He referred to his experiments on the [illegible] painting, and that not any [illegible] process however good on paper must also be exceptionally good in the laboratory.

Mr Andreoli jun., referred to the anodes, and the [illegible] anodes that had been used, and to Harold's experiments [illegible] on the density of solution, the carbon being less [illegible] the denser solutions. Electrolytic bleaching had not [illegible] [illegible] to a great extent, it had been [illegible]. He [illegible] many of the difficulties, but said the [illegible] was the production of chlorine and caustic alkali. [illegible] simplified the problem, and allowed denser solution to be used, the only difficulty being that hydrogen is separated by [illegible] and an explosive mixture is formed.

Mr Cooper, answering Mr. Andreoli, granted that there [illegible] been difficulties such as mentioned, which in the Hermite [illegible] had been got over years ago. At the present moment on the Continent they were replacing in paper and other [illegible] to 3,000 tons of bleaching powder per annum. As to [illegible] would be pleased to show those interested the figures, [illegible] showed in cases where water power, reckoned as costing [illegible], was used, a saving of 50 per cent., and where steam [illegible] used, reckoning £[illegible] for 1 h.p. for 24 hours, a saving of [illegible] per cent.

Mr Blunt referred to the electrolytic extraction of [illegible] hopeful, but it would be still more hopeful when [illegible] would be treated directly. Mr. Swinburne had [illegible] the Hoffner process, and wondered why the chloride was [illegible] to the sulphide. The reason was that chlorides were [illegible] and easily formed than sulphides, and the sulphur was [illegible] left free. It seemed to the speaker that the greatest difficulty was in the anode [illegible] to stand. The latest [illegible] [illegible], but its value was not yet [illegible]. He had found Greenwood's anode fairly satisfactory, but [illegible] only tried it experimentally.

Mr J. W. Swan had sent a communication, in which [illegible] pointed out that in estimating the kilowatt hour, the [illegible] used was not mentioned. [illegible] to electro-deposition, but in face of the [illegible] tion of placing large plates in the Siemens [illegible] no longer [illegible]. He had found that aluminium [illegible] deposited when getting [illegible] per square foot [illegible] at the rate of 1 gramme per sq. ft., and with [illegible]. With reference to extraction of zinc [illegible] there might be great improvement in present zinc smelting. [illegible] was a great waste of both coal and metal, resulting in a [illegible] 20 to 30 per cent. Among [illegible] processes, [illegible] has not been [illegible] of soda.

Mr Mordey [illegible] that in a class experiment [illegible] when [illegible] had been given off. He [illegible] effect mentioned [illegible] authorities, but it was [illegible] Faraday [illegible], 1834 *Researches*, vol. i., para. [illegible].

Mr Richardson agreed with Mr. Andreoli that [illegible] of [illegible] to density of solution [illegible] deleterious chemical actions were avoided with [illegible] solutions. In bleaching, it is not the chlorine directly that is material; it is oxygen that acts. [illegible] electrolysis it was the secondary action that [illegible]. He thought hypochlorite solutions would not pay [illegible] special circumstances.

Mr Faulkner did not agree with Mr. Andreoli, but [illegible] to be better than anticipation. If platinum anodes were [illegible] then [illegible] were better.

The **President** referred to Mr. Mordey's experiment [illegible] allowed was important, if electrolytic; in fact, it pointed to direct obtaining of current by burning carbon. [illegible] had been made to electric transfer as supposed to exist in electric tanning.

Mr Sinclair disagreed with the estimate of ½d. per kilowatt hour, and thought ¾d. would be nearer. An anode [illegible] good but would not last. For a good anode there was an [illegible] limited future.

Mr Swinburne, replying, said he was pleased to see [illegible] eminent chemists present. With regard to cost he had taken a plant of 1,000 h.p., coal at 10s. a ton; he had allowed 2lb. of coal per indicated horse-power; a 1,000 h.p. [illegible] showed [illegible] would. He had taken combined efficiency of engine and dynamo at 85 per cent., which could [illegible] cost less than £[illegible] h.p., or, and [illegible] £700, and [illegible] Willans engines at [illegible], and [illegible] at [illegible] per cent. and depreciation at [illegible] per cent., running night and day. The [illegible] came to £[illegible], which was [illegible] ½d. per kilowatt hour. He had stated that wide allowance should be made in practice. He knew some firms were going ahead with electrolysis [illegible] referring, but as his paper had not been [illegible] on [illegible] papers he thought chemists did not recognise the [illegible]. He had not referred to Mr. Swan's process as his paper was already written. The deposition of aluminium would be [illegible] [illegible] current was expended. He had [illegible] [illegible] tanning and [illegible], which was [illegible] to be [illegible] by [illegible]. He [illegible].

A vote of thanks was accorded to Mr. Swinburne for his important paper.

The **President** announced that Mr. David Salomons had [illegible] at the position as temporary hon. treasurer in place of [illegible] [illegible].

The meeting was adjourned to next Thursday, when a paper will be read by Dr. Fleming on "Experimental [illegible] on Alternate Current Transformers."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

COMMERCIAL ELECTROLYSIS.

SIR,—In your issue of last week you gave a short report of the remarks made by myself at the meeting of the Institution of Electrical Engineers last Thursday.

I shall be obliged if you will allow me space to correct two slight inaccuracies in that report. I stated that an ordinary "electrolyser" as used in the "Hermite" process was worked at five volts and 1,000 amperes. Your report puts it the other way round, and it must have struck your readers that Mr. Rawson's anticipation of leakage would very likely be realised. The second point was regarding the renewal of platinum anodes. I stated that an installation of 10 electrolysers working continuously for five or six years, only one set (consisting of 52 plates) of new ones was supplied, the plates being distributed among 10 machines.—Yours, etc., CHARLES F. COOPER.

3, Princes-mansions, S.W., Nov. 15, 1892.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

SIR,—If I take up my pen to comment upon the manifesto of Messrs. Erskine, Manville, Mavor, Raworth, and Swinton respecting the composition of the Council of the Institution of Electrical Engineers, it is not at all to formulate any reply to the indictment framed by these good men and true. I merely wish to complete their statement which, it is well known, embodies partially sentiments that exist pretty widely in the Institution, within the Council as well as without. In other words, there are members of the Council who as individuals recognise, perhaps even more clearly than do Messrs. Erskine, Manville, Mavor, Raworth, and Swinton, the shortcomings which they have in part pointed out. As it is, in the natural course of things, my turn to retire from the Council in six weeks' time, I can speak the more impersonally. The object dear at heart to the memorialists can, therefore, in one instance, be readily attained without friction.

Let me first begin by classifying a little more definitely the membership of the Council (I take the official list, as the memorialists did; but, alas! we have just lost Mr. Graves). As the term electrical engineer has no legal or recognised definition, and as every gasfitter is nowadays an electrician, I avoid these indescriptive terms. In passing, I remark how strange it is that the memorialists are able to discover no fewer than 10 professors who are neither "electricians" nor "electrical engineers." Perhaps Prof. Hughes never was an electrician in spite of his well-known inventions. Perhaps Prof. Hopkinson never was an electrical engineer. But in that case—dreadful thought—who is? However, let that pass.

The Council, including past-presidents and vice-presidents, consists, indeed, of the following:

Manufacturers and contractors	5
Telegraph, telephone, and cable men	13
Chemists	2
Engineers in consulting practice not included in above	6
Baronets	1
Engineers to manufacturing firms	1
Government officials not included in above	2
Teachers of electricity not included in above	2
	32

or, omitting past-presidents and vice-presidents:

Manufacturers and contractors	2
Telegraph, telephone, and cable men	5
Chemists	0
Engineers in consulting practice not included in above	5
Baronets	0
Engineers to manufacturing firms	1
Government officials not included in above	2
Teachers of electricity not included in the above	0
	15

Inspection of these figures at once shows on what head the Council is overweighted. But, then, the Institution must be forgiven for the circumstance that it originated as a body of telegraph engineers, and not as a body of manufacturers or contractors.

But really there is a grain of reason in the contention that there are in the Institution and on its Council gentlemen "only indirectly connected with practical engineering." Too often the phrase "practical engineer" is held to denote one who has served seven years of drudgery at the bench. Well, but that is precisely (my friends will pardon me for so personally using them as examples) what my friend John Perry, engineer and professor, did; it is precisely what my friend William M. Mordey, engineer and inventor, did not do. It is within the bounds of possibility that there may be contractors and manufacturers who are even less directly connected with practical engineering.

It is a pity for the memorialists' case that they have so sadly understated the "professorial element" on the Council. Their delicately-concealed suggestion that if a man has at some time or other held a responsible post as a teacher, that circumstance in some way disqualifies him to take part in managing a "professional" body such as the Institution, reaches more widely than to the 10 "professors" (including Lord Kelvin) so denominated in the official list of the Council. To these 10 should be added Prof. Sir Frederick Abel, Prof. John Hopkinson, Prof. (now General) Webber, and Prof. Crookes, not to add Mr. Mordey and Mr. Swinburne, both of whom have qualified themselves for the same courtesy by systematic teaching. So the 10 should be written 16. It is evidently high time that the number of "professors" on the Council should be reduced. There is also an undue proportion of members of Council whose names begin with the letter C. Moreover, compared with the Civil Engineers, there is a smaller proportion of "Sirs" on the Council. This is a sad oversight which might be commended to the notice of the P.M.G. (I do not mean the *Pall Mall Gazette*.)

What seems to be the saddest fault of all, is the complete absence from the Council of any member who, being neither an engineer in consulting practice, a teacher, a soldier, a sailor, an officer in the volunteers, a Government official, a company director, a company promoter, a cable man, a telegraph operator, a chemist, an author, a a peer, or a baronet, and never having been any one of these things, shall be therefore competent to represent "those actively engaged in constructive work." The omission is not, however, irremediable. Doubtless the Council, awakened at last to a sense of its shortcomings, will fill one of the shortly vacant places by the member entitled to such unique distinction—if he can be found.—Yours, etc.,

SILVANUS P. THOMPSON.

THE ELECTROMAGNETIC THEORY OF LIGHT.*

BY JAMES H. GRAY, M.A., B.SC., PRESIDENT.

(Concluded from page 473.)

Coming to the case of other dielectrics than air, we must have $\frac{1}{\sqrt{K\mu}}$ = velocity of light in the dielectric, but the velocity of light varies with the wave-lengths; in other words, there is dispersion, and we meet with the great difficulty that is as yet not completely explained by any optical theory. If we are to explain dispersion, we must assume that either K or μ, or Kμ, varies with the length of the waves. In order, therefore, to get a fair comparison, we must take electromagnetic waves and light-waves of as nearly the same length as possible. Now, the highest frequency of vibration for which K has been measured is 25 millions per second. In the electrostatic system of measurement we have $\mu = \frac{1}{v^2}$ for air, and practically so for glass and other dielectrics, $\therefore \frac{v}{\sqrt{K}} = v^1$ the velocity of light in glass. But $\frac{v^1}{v} = \frac{1}{k}$ where k is the index of refraction of glass. Therefore $\sqrt{K} = k$. Prof. J. J. Thomson (*Proceedings* Royal Society, June 20, 1889), and Blondlot (*Comptes Rendus*, May 11, 1891) found that $\sqrt{K}$ approximated to k for a frequency of 25 millions per second. Dr. John Hopkinson (*Phil.*

* Presidential address delivered before the Physical Society of Glasgow University.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

V.—WATER POWER.

(Continued from page 447.)

This is a source of power that exists to a very limited extent in England, because the rivers are not of a rapid nature, and there are very few waterfalls of any size. In a country like Switzerland water power is abundant, due to the swift mountain torrents and waterfalls that are met with everywhere. It is, therefore, only natural that the Swiss engineers are famous for the turbines manufactured by them, and their experience in utilising this source of power. Water power, for motive purposes, is used all over the world whenever it can be obtained and proves a most valuable and cheap source of power where coal or any such fuel is scarce and expensive. The development and practical application of transmission of power by electricity has made a good source of water power of still greater importance and value, since by electricity the energy of the water, instead of running to waste, can be transmitted a number of miles and there utilised, subject to a loss depending on the distance and the method employed. This matter will be discussed later on in the chapter relating to "Electric Transmission of Power." For the present water power will be simply referred to in a brief way as a source of motive power.

A moving body of water may be said to deliver its power in two general ways, in a practical sense: first, by momentum; second, by weight. A rapid stream explains the first, a waterfall explains the second. All water motors may be divided into two classes: (I.) Waterwheels (horizontal axis), (II.) turbines (vertical axis).

(I.) *Waterwheels.*—This class of water motor may be again divided into three types, namely, (*a*) undershot, (*b*) overshot, (*c*) breast.

The undershot waterwheel is the oldest form of any device used to obtain power from a moving body of water. Figs. 1 and 2 show an undershot wheel. The water flows in what is named a "race," the part in front of the wheel being called the "head race," whilst the part behind the wheel is called the "tail race." In the head race the water is flowing at its normal rate, and so is in a condition to do work. Upon reaching the wheel, which offers an obstruction, the water forces the floats in front of it, and so turns the wheels; the water now has parted with more or less of its power, and so continues its way at a slow rate into the tail race. The shaft of the wheel, which is of wood, is encircled by an iron socket fastened to it by wooden pins. The radial arms are set in the socket and fastened with bolts. An iron ring is fixed on and supported by these arms, the ring being in segments, each segment being fastened to its corresponding arm by iron bands; the segments are also joined together by iron bands.

The floats are pieces of board, about 1in. to 1½in. thick; these have the same width as the rim of the wheel, and are supported by stout wedges of wood placed behind them. The diameter of the wheel determines the number of arms. With a diameter of, say, 12ft., there would be about six arms, the floats being placed about 15in. apart. That portion of the race just underneath the wheel is curved out, so as to fit the wheel, the race being made the same breadth as the wheel. The average depth of water should be about 7in. or 8in., and this depth is regulated by a gate, fixed in a slanting position; by raising or lowering this gate, a greater or less quantity of water can be admitted through the open space between the bottom of the gate and the bed of the race. The angle of slant for this gate must be such that there is a very small distance between the opening and the tips of the floats. By this means the water impinges right on to the floats immediately on getting through the gate, and so power is not lost.

Undershot wheels should be used where the streams are rapid, contain large bodies of water, and are not subjected to much rise or fall, for in the event of a flood the wheel would become "drowned," and its power crippled.

The great advantages which an undershot wheel possesses are cheapness in first cost and simplicity of construction, so that it would not be very difficult for anyone to make one for themselves, and they would find that the cost would not be much.

The Overshot Waterwheel receives its power as much from weight as from momentum of the water. In place of a "flume," in which the undershot wheel receives its power, the water is delivered to the overshot wheel from above, so that it falls just beyond the top centre into buckets attached to the periphery of the wheel. Fig. 3 gives an illustration of an overshot wheel, and the way in which water is delivered to it. A wooden trough, made of planks, delivers the water; at the end of the trough a thin piece of iron is fixed on the bottom of the trough and projects out, forming a lip; this lip reaches the wheel a little in advance of the vertical diameter of the wheel; the water as it rushes out leaps off the lip and so is carried a short distance forward, and, therefore, falls on the buckets a little beyond the top of the wheel. A

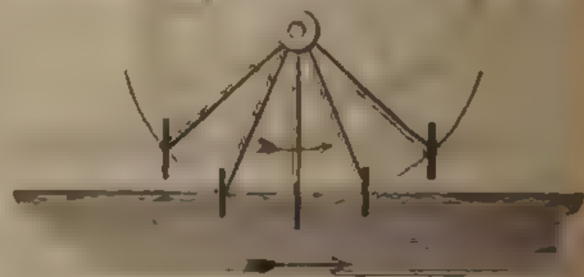


Fig. 1.

sluice is fixed at the entrance to the trough, and so the water can only enter in a thin stream. This type of wheel can only be used where there is a good fall of water; quantity of water does not much signify, provided there is a fall. It may be reckoned that an overshot wheel requires a fall about 1¼ times the diameter of the wheel.

The Breast Waterwheel is a combination of the undershot and overshot, and is probably more used than either of the others. As with the undershot, a flume of masonry is built for the race; the walls of the flume are so made that the wheel will just fit in, there being no space ... left between the floats and the walls. This is in order to prevent any water from escaping past the floats. Fig. ... shows how the water is delivered to a breast wheel. A curved piece of iron fixed at the entrance to the flume is called the "guide bucket." A gate, capped with an ... beak, called the "sole of the weir" (not shown in Fig. ...) is often used, the water flowing over the "sole" and striking the floats just below the axis of the wheel as it does in Fig. 4.

Fig. 2.

For high speed, use wide floats and small diameter.
For low speed, use narrow floats and large diameter.

The following is the efficiency of the three types of waterwheels:

Overshot utilises	50 to 70	per cent.
Breast utilises	45 to 50	,,
Undershot utilises	27 to 30	,,

The Pelton Waterwheel.—This motor is a great improvement on the ordinary wooden waterwheel, being built of iron and encased by an iron shell, the water being fed into it by an iron delivery pipe; a regulating wheel valve regulates the amount of water admitted, and so the power of the motor can be varied. These motors have lately been provided with a throttle valve and centrifugal governor, so that the speed can be regulated when the load varies.

(II.) *Turbines.*—This class of water motor may be divided into two types—namely, (*a*) outward flow, (*b*) inward flow.

When the power is used for driving dynamos, and running

electric lights direct from the dynamo, then a turbine should be used, because a waterwheel cannot be depended on to run steadily; an ordinary waterwheel with its irregular running is quite good enough for driving a dynamo, when it is only used for charging accumulators, because it is not absolutely necessary to have a constant speed, and a variation of speed will not matter, provided it is within reasonable limits. Of course a great deal depends on the nature of the water power. In districts where it remains fairly constant in power the lights can be run successfully by a waterwheel, provided that some regulator is used, such as putting an electrical regulating device across the main terminals of the dynamo, so as to throw resistance in and out of the shunt coils.

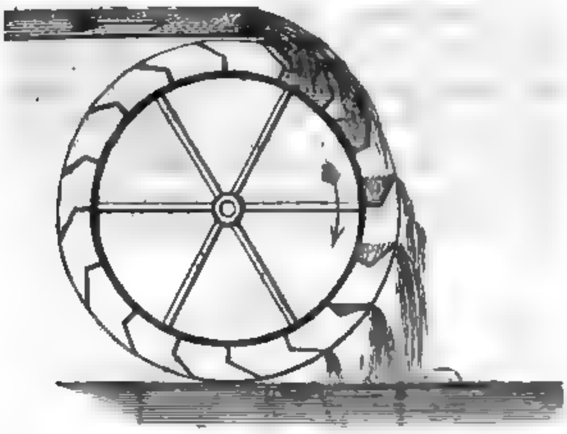


Fig. 3.

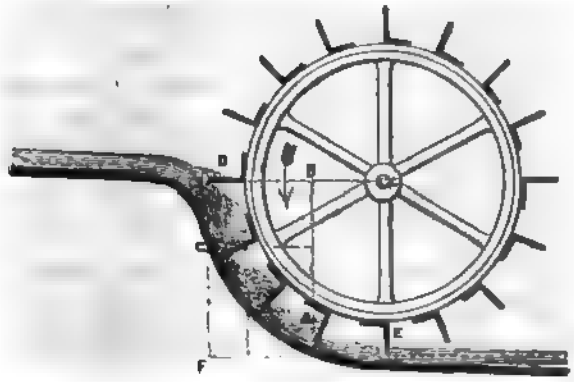


Fig. 4.

The principle underlying the action on which turbines work, may be termed to be the effect of a reactionary force. For an example of what is meant by this definition, it will be remembered that the first instance in which steam was employed to promote motion, and consequently yield power, is generally ascribed to Hero of Alexandria, who partly filled a metal sphere with water and attached two curved spouts diametrically opposite to each other; upon boiling the contained water steam issued from the spouts, one jet rushing upwards and the other jet rushing downwards, and the sphere, being pivoted, revolved. This illustrates to some degree the signification of reactionary forces. The following explanation given by Bodmer will aid in understanding this principle of reaction as regards water: "The construction of turbines is based upon the fact that when a mass moving in a given direction with a given velocity is impelled to change this direction, force is required to effect this change. The intensity of the force necessary is obviously dependent on the extent to which the mass is deflected from its original course. In a turbine a jet of water is deflected by being brought into contact with a curved vane, which, preventing further progress in the initial direction, compels the water to follow its surface. Owing to the resistance offered by the water to this compulsion, a reactionary force is exerted on the vane which is employed driving the turbine wheel." Fig. 5 illustrates how the above reactionary force is practically applied, where, instead of the water being turned abruptly from a vertical to a horizontal course, the arms make a curve, as seen in the section; in addition to this the arms are curved horizontally, as seen in the plan.

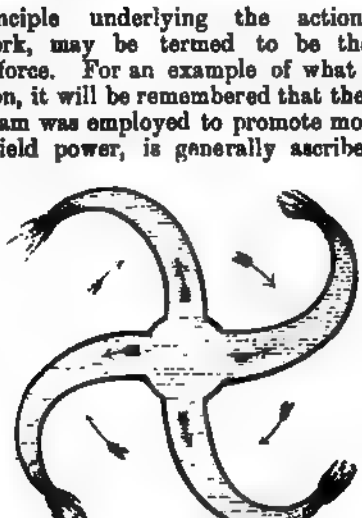


Fig. 5.

In outward-flow turbines, the water enters at the centre, and leaves at the circumference, the guides being placed inside the wheel. In inward-flow turbines, the converse holds—that is, the water enters at the circumference and leaves at the centre, the guide blades being fixed round the periphery of the wheel. A good turbine should give out 70 per cent. of the available power, so that they are far more efficient than waterwheels.

How to Calculate Water Power.—After the explanations given as to the meaning of horse-power and how it is calculated in a steam engine, it will not be very difficult to apply the same to water power. Quantity of water is usually stated in gallons, but in calculating power the water must be measured in pounds weight, for the term gallons is no use, and has to be changed into weight. When the water yields power, by virtue of its dead weight, as when it falls freely from a height, then the theoretical power it gives out just upon reaching the ground is measured simply by the weight in pounds per minute that flows, and the distance in feet that it falls (neglecting air resistance). Now one cubic foot of water weighs 62·5lb., therefore one cubic foot per minute falling 1ft. will yield 62·5 foot-pounds per minute, and since 33,000 foot-pounds make 1 h.p., therefore 528 cubic feet of water per minute, or 8·8 cubic feet per second, falling freely 1ft., will produce 1 h.p. In order to obtain the number of cubic feet of water, the velocity of the water must be measured as near to the fall as possible. The average depth and width of the stream multiplied together give the average sectional area of the water that is flowing, therefore multiplying this by the velocity in feet per minute will give cubical amount of water that flows per minute.

Example.—Suppose a stream, having an average depth of 5in. and an average width of 9ft., has a free fall of 13ft.; find its horse-power, the velocity just above the fall being, say, five miles per hour.

The sectional area $= 9 \times (5 \div 12) = 3{\cdot}75$ square feet;

Five miles per hour = 440ft. per minute;

$\therefore$ quantity of water per minute $= 3{\cdot}75 \times 440 = 1{,}650$ cub. ft.

$\therefore$ weight of water per minute $= 1{,}650 \times 62{\cdot}5 = 103{,}125$lb.

Hence, power developed $= \dfrac{103{,}125 \times 13}{33{,}000} = 40{\cdot}6$ h.p.

In the above case we have measured the power given out by the water by a certain weight of water in pounds falling a certain distance in feet in a certain time—one minute—that is to say, in foot-pounds per minute.

Now turn attention towards measuring the power of water developed, not by weight, but by momentum. Momentum signifies the stored-up or kinetic energy possessed by a body by reason of its velocity.

When a mass of water is travelling along at a certain velocity, the amount of power it would yield upon being suddenly stopped, would be equal to the amount of power that was given to it in order to give it that velocity. The simplest way to find out what amount of power a moving mass has is to calculate out what vertical distance the mass would have to fall, acted upon by gravity, in order to acquire that velocity, and then to proceed as usual. A body falling freely is constantly accelerating its velocity or rate of motion. Thus it starts from rest, having a velocity of 0,

and goes on increasing in velocity until at the end of one second of time its velocity is 32·2ft. per second, and its *average* velocity throughout the space of that second is naturally $(0 + 32·2) \div 2 = 16·1$ft. per second, and the distance fallen is 16·1ft. In the next interval of time, its *initial* velocity is already 32·2ft. per second, while its final velocity is 64·4ft. per second at the end of the second second; hence its *average* velocity during the two seconds is $(0+64·4) \div 2 = 32·2$ft., and so on until at the end of 12 seconds its *final* velocity would be 386·4ft. per second, its average velocity $(0+386·4) \div 2 = 193·2$ft. per second, and therefore the total space covered by the falling body would be $193·2 \times 12 = 2,318·4$ft., so the law is—

$$\text{Space} = \{0 + (32·2 \times \text{time})\} \div 2 \times \text{time, or } s = 16·1\, t^2,$$

where s = space in feet, and t = time in seconds.

In words this means that the distance in feet a body will fall is obtained by multiplying the square of the time in seconds by 16·1.

Example.—A stone falls down a precipice; at the end of four seconds it is seen to strike the surface of a pool of water at the bottom; how deep is the precipice? Applying our rule, we have

$$s = 16·1\, t^2 = 16·1 \times 16 = 257·6\text{ft. deep.}$$

We have now obtained the law connecting space and time for falling bodies, and from this we have to deduce another law—one connecting final velocity and space—so that when a mass is moving at a certain velocity we can find out what distance it would have to fall in order to acquire that velocity. This law would then enable us to measure the energy of the moving mass, for the weight of the mass multiplied by its distance of falling (expressed as a function of its velocity), will give us the foot-pounds of energy it would develop upon being suddenly stopped.

The following is the deduction: Indicating final velocity by v, $v = 32·2\, t$; therefore by dividing the velocity of the mass by 32·2, we obtain the number of seconds it would have to fall to acquire that velocity, and knowing this, the space covered can be easily calculated from the previous law, $s = 16·1\, t^2$, since by substituting the value of t, we get $s = 16·1 \times (v \div 32·2)^2$ = space. This is worked out in the following way:

$$v = 32·2\, t\,;\ \therefore t = v \div 32·2\,;\ \therefore t^2 = (v \div 32·2)^2\,;$$

$$s = 16·1\, t^2\,;\ \therefore s = 16·1 \times (v \div 32·2)^2 = \frac{v^2}{64·4}.$$

Our law, then, is this: Square the velocity of the mass, expressed in feet per second, then divide by 64·4. The answer gives the distance in feet the mass would have to fall, acted on by gravity to acquire that velocity. Hence the stored energy possessed by a moving mass $= \frac{(\text{velocity})^2}{64·4} \times$ weight in pounds.

Example.—Suppose a swift stream of water rushing down an incline at the rate of seven miles per hour, its average depth being 9ft. and its width 25ft.; what horse-power will the stream produce?

Seven miles per hour = 10·26ft. per second;

Cross-section of channel = $25 \times 9 = 225$ square feet;

Mass of water flowing by per second = $225 \times 10·26 = 2,308·5$ cubic feet;

Weight of water flowing by per second = $2,308·5 \times 62·5 = 144,281·25$lb.;

$$\therefore \frac{(\text{velocity})^2}{64·4} \times \text{weight} = \frac{(10·26)^2}{64·4} \times 144,281·25$$

$$= 231,615·6 \text{ foot-pounds per second.}$$

$$\text{Hence horse-power} = \frac{231,615·6}{550} = 421·1.$$

The following tabulation gives a number of values of velocity worked out in their equivalent values of distance:

V = velocity = number of feet per second.

S = space or head in feet.

TABULATION 13.

V	S	V	S
1	·01	20	6·2
2	·06	30	13·9
4	·24	40	24·8
6	·55	50	38·8
8	1·00	60	55·9
10	1·55	80	100·0

Feet per second = $1\frac{1}{2}$ times the number of miles per hour ($2\frac{1}{4}$ per cent. too high).

Miles per hour = two-thirds the number of feet per second ($2\frac{1}{4}$ per cent. too low).

The preceding values are plotted out in a curve, as shown in Fig. 6, where velocities are plotted along the vertical axis, and the spaces along the horizontal axis.

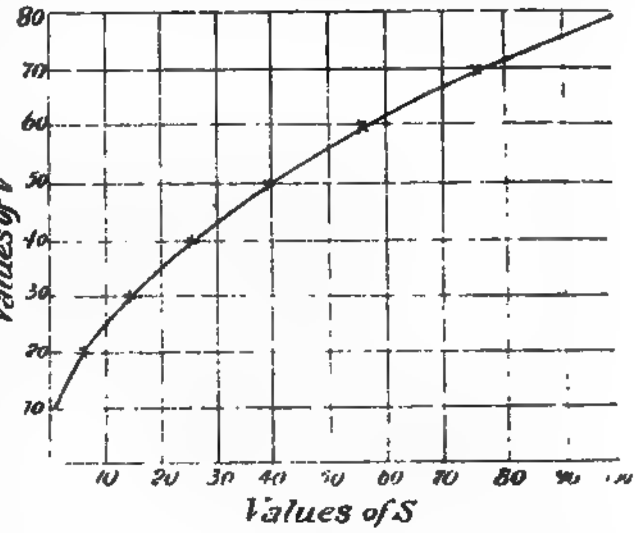


FIG. 6.

Since one cubic foot of water weighs 62·5lb., therefore the energy of one cubic foot of water moving with V velocity is

$$\frac{V^2}{64·4} \times \frac{62·5}{1} \text{ foot-pounds.}$$

Multiplying this by the number of cubic feet of water that flow by per second, will give the foot-pounds developed per second by a volume of flowing water: 550 foot-pounds per second are equivalent to 1 h.p., and since 62·5 is sufficiently near to 64·4 for approximate results, these two factors can be omitted. Now, volume in cubic feet per second is the product of cross sectional area in square feet and velocity in feet per second: hence this formula may be written

$$\frac{V^2 \times \text{area} \times V}{500} = \frac{V^3 A}{500} = \text{H.P.}$$

Where V = velocity in feet per second,

and A = cross-sectional area of stream in square feet.

We can thus obtain the horse-power of a flowing stream of water by the use of the following rule for approximate results only: Cube the velocity of the stream, expressed in feet per second, multiply this by the average cross-sectional area, expressed in square feet, and then divide by 550.

The above rules for calculating water power only give theoretical results, since there are several things which must be taken into consideration in obtaining the actual power—for example, the depth must be very carefully noted in several places, and only the mean or average taken. Then again it must be remembered that the water at the bottom and at the bank sides flows slower than that in the central parts of the stream. This is due to the friction existing between the earth and the water near it, for everyone knows that in rowing against the stream a boat should hug the bank.

(To be continued.)

FINE ART ELECTRICAL FITTINGS.

The development of electricity as a means of light has given an immense impetus to the industry of the fitting trade, and undoubtedly a certain degree of success has been achieved in this country in producing designs which compare favourably with the chandeliers and other appliances in use for lighting by gas. This concession, however, is but faint praise when it is considered how inartistic, and in the majority of cases how hideously ugly, are the gas

Natural-Tinted Floral Electric Fittings.

fittings to which we have so long accustomed ourselves to tolerate. The great difficulty experienced by the great number of makers of electroliers seems to be to shake off the old conceptions, and to get rid of the antiquated traditions connected with gas chandelier designing. So tenaciously do these workers cling to the old forms that it would appear almost hopeless to expect them to leave the gas-chandelier prejudices behind and strike out in an entirely new direction. The art of lighting by electricity lends itself to so many possibilities due to the nature of the new illuminating power that we have long expected to see a larger amount of really artistic development in the gigantic industry which has been brought about by the invention of the incandescent lamp. We have been shown some very artistic fittings recently introduced by Messrs. John Davis and Son, of All Saints' Works, Derby, which can be seen at their London showrooms, 118, Newgate-street. These possess the merit of perfect freedom from the objectionable gas-chandelier type, and should meet with great favour for house lighting of the better type. The designs are very numerous, reaching upwards of 500, so that every variety of condition may find its requisite design of fitting. The electroliers, in varied floral designs, for two up to fifty lamps, are suitable either for the smallest room or the largest saloons or halls of palaces. Brackets, wreaths, cornice lights, theatre-box illuminations are all well represented. The designs are not only elegant, but the workmanship is of a high order, the finish being in gilt, silver, bronze, or a combination of all.

A special feature of the firm's work is the production of floral fittings in natural tints, flowers and foliage being enamelled by a special process in spring, summer, or autumn colouring. The effect is very striking and peculiarly harmonious under the brilliant light of the incandescent lamp. This enamelled work has, moreover, the important advantage of resisting the wear and tear of time, as a wet cloth or sponge suffices to renew the freshness of the work to its original condition.

We must refer our readers to Messrs. Davis and Son for the privilege of inspecting their specimens and photographs at their City showrooms. We illustrate a few representative pieces, which will convey some impression of the new departure in electric fittings.

ABSTRACT OF REPORT ON TRIALS OF PARSONS'S CONDENSING STEAM TURBINE, USING SUPERHEATED STEAM.

BY PROF. EWING, F.R.S., M.I.C.E., CAMBRIDGE UNIVERSITY.

(Concluded from page 483.)

In the second set of trials the object was to test the effect of additional superheating. A special furnace, built into the uptake of the boiler flue, was made to give additional heat to the superheater, bringing the temperature of the steam to 165deg. F. In this set of trials the continuous current armature was again used, and the measurements were made in the same way as in the first set. Three different grades of output were tested. The results are given in Table II.

In the third set of trials the alternate current armature was used, giving 2,000 volts at a speed of 4,800 revolutions per minute, which made the frequency of alternations 80 periods per second. Here the current was directly measured by the Everett and Siemens instruments, and the volts were determined by (1) a Cardew voltmeter furnished with a resistance specially wound to enable it to read 2,000 volts, and independently (2) by another Cardew voltmeter with a step-down transformer having a ratio of 1 to 20. The output was taken to be the product of the effective volts and the effective amperes. In these alternate-current trials the electrical energy was absorbed by a water resistance formed by sticking two rods, to serve as terminals, some 10 yards apart in a pond, the amount of resistance between them being adjusted by pulling the rods out or in to expose more or less of their surface to contact with the water. In this third set of trials the steam was moderately superheated as in the first set, by the hot gases of the boiler flue only, its temperature again approaching 400deg. F. The results are given in Table III. The close agreement of them with the corresponding continuous-current trials, Table I., is important, as supplying evidence that in alternate-current trials conducted in this manner the effects of lag in the external circuit are immaterial, in other words that the electrical work is properly measured by multiplying the effective volts by the effective amperes. The difference between the alternating and continuous-current measurements is less than 1 per cent. of the output at full load.

In each of the trials the turbine was kept running for a [illegible] time beforehand to establish a nearly uniform regime. [illegible] was kept up long enough to prevent any material error from arising in the [illegible] readings of the water level in the boiler gauge glasses. In each trial the amount of the feed water was measured during two successive equal periods of time, to test the agreement of these with each other. The air pump and [illegible] pump were driven by donkey engines, the steam for which was supplied from a separate boiler, and is not included in the figures given below. What the tables give is the gross amount of feed water actually delivered to the main boiler, from which the whole supply of steam for the turbine was drawn.

The temperature of the steam was read by a thermometer placed in a mercury pocket in the steam pipe, close to the turbine. A pressure gauge placed there showed that the pressure was, at full load, between 2lb. and 3lb. per square inch less than the pressure at the boiler. The amount of superheating in the trials of Table I. was comparatively small under light loads, because the boiler [illegible] was not then being forced; from half load to full load it was nearly uniform.

TABLE II.—Trials with Continuous Current Armature, with Extra Superheating.

Pressure by gauge on boiler, lbs. per sq. in.	Temperature of steam, deg. F.	Load in electrical units per hour.	Feed water per hour in lbs. Total.	Per unit.
102	463	28·3	1,000	[illegible]
102	468	49·5	1,480	[illegible]
101	465	78·4	2,170	[illegible]

Vacuum by gauge on condenser, 28¼in. Barometer, 29·5. Temperature of injection water, 72deg. F.

TABLE III.—Trials with Alternate-Current Armature and Water Resistance. Superheating by the Gases from the Boiler Furnace.

Pressure by gauge on boiler, lb. per sq. in.	Temperature of steam, deg. F.	Load in electrical units per hour.	Feed water per hour in lbs. Total.	Per unit.
99	367	31·6	1,180	[illegible]
97	394	49·9	1,550	[illegible]
103	399	105·2	2,970	[illegible]

Vacuum in full power trial: By mercury column at [illegible], 27¼in.; by gauge on condenser, 28¼. Barometer, 29·6. Temperature of injection water, 72deg. F.

The results are also exhibited in the curves, Figs. 3 and 4. The rate of electrical output is shown in relation to the whole consumption of feed water per hour, in Fig. 3, and in relation to the consumption of feed water per electrical unit, in Fig. 4. The line A A in each diagram refers to the first set of the present trials, those of Table I., which were made with continuous current and moderate superheating. The points of observation are marked thus [illegible]. The points marked [illegible], which lie very close to [illegible] and a trifle below it, are for the tests made with alternating currents, Table III. The line B B in each diagram refers to the trials with extra superheating, Table II. The points of observation are marked thus [illegible].

To facilitate comparison, the amount of feed water used per electrical unit at various rates of output, as measured from the curves of Fig. 8, is given numerically in Table IV.

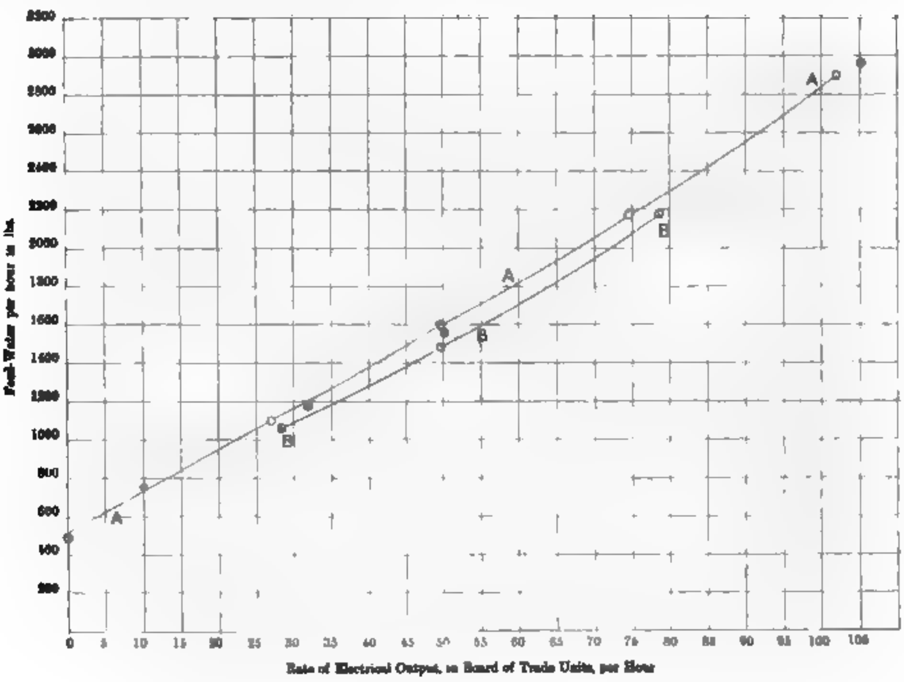
TABLE IV.—Consumption of Feed water at Various Rates of Output, with Superheating.

Rate of output in electrical units per hour.	Feed water per electrical unit. With superheating to about 400deg. F.	With extra superheating to [illegible]
20	48	
30	39	36½
40	34½	32
50	32	29¾
60	30¼	28
70	29¼	28
80	29	27½
90	28¾	[illegible]
100	28½	[illegible]

The trials show that a very considerable advantage is realised by moderate superheating. To superheat the steam from, say, 338deg. F., the temperature of saturation for a boiler pressure of 100lb., to 400deg. F. requires the addition of barely 30 units of heat, which is less than 3 per cent. of the heat taken up in the boiler. With steam superheated to this extent the consumption at full load is less by one-fourth than the consumption in the [illegible] trials. How much of this increase in economy is due to superheating alone cannot well be distinguished without further tests, as the comparison is complicated by the other improvements referred to at the beginning of this report. It is clear, however, that superheating is responsible for a great part of the [illegible]. Apart from the increased volume of the working substance, the advantage of superheating is to be ascribed in part to the prevention or reduction of the condensation which would otherwise take place in consequence of the [illegible] of admission, and in part to its influence in keeping the steam dry during its expansion, and thereby reducing the internal [illegible]. At full load, when the steam enters in a nearly continuous [illegible], the latter effect is no doubt the more important.

The further advantage realised by superheating to 465deg. F. is comparatively small, especially at high loads. From [illegible] given by the temperature of the turbine case it was clear that this amount of superheating not only kept the steam dry throughout its whole course through the turbine, but left it still considerably

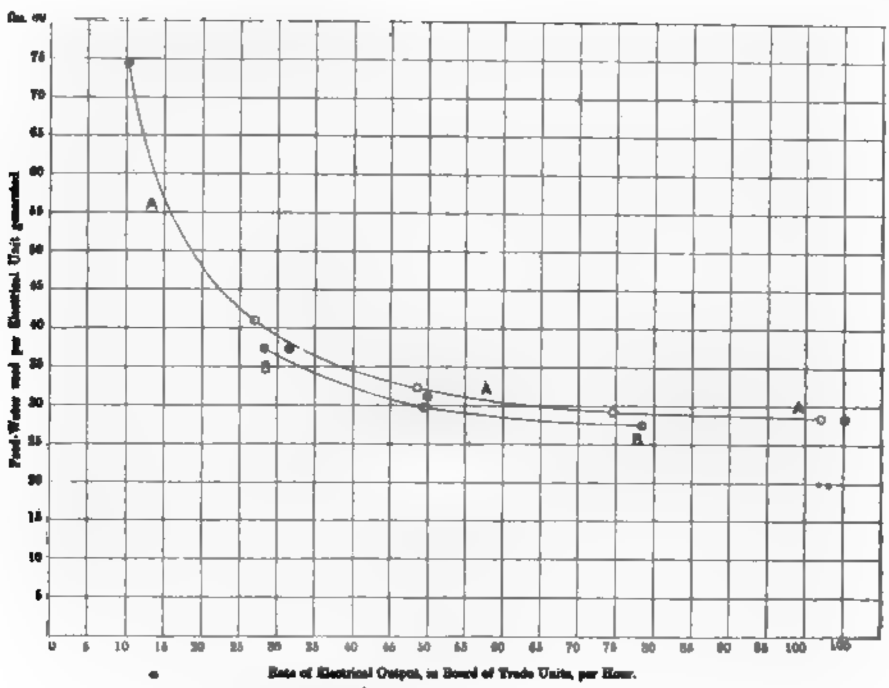
superheated at the end. The part of the case next the exhaust, which had been quite cool in the trials of Table I., was decidedly hot in those of Table II. This observation agrees with the result of calculation, which shows that an initial temperature of about 443deg. F. would be high enough to prevent the steam from becoming wet as it expands.* It may be concluded from this consideration, as well as from the results of the trials, that very little increase of efficiency is to be brought about by carrying the superheating further than this. It seems, therefore, undesirable to push the superheating to a higher point than can readily be reached by the use of a superheater in the boiler flue. With a superheater of moderate size the hot gases of the uptake will furnish as much superheating as need be aimed at, and as much as is sufficient to secure highly economical working.



Trials of Parsons' Steam Turbine and Dynamo, August 1892.
A A.—Steam superheated to about 400° Fah., Continuous current trials ; Alternating current trials
B B.—Steam superheated to 465° Fah., Continuous current trials

FIG. 3.

The general result of the trials is to demonstrate that the condensing steam turbine is an exceptionally economical heat engine. The application to it of moderately superheated steam has put the performance of the turbine on a level with that of the best steam engines of the ordinary type. A consumption of 27lb or 28lb. of steam per electrical unit, at full load, and 30lb. or 32lb. at half load, is a result that does not need to have its significance emphasised. The efficiency under comparatively small fractions of the full load is probably greater than in any steam engine, and is a feature of special interest in relation to the use of the turbine in electric lighting from central stations.



Trials of Parsons' Steam Turbine and Dynamo, August 1892
A A.—Steam superheated to about 400° Fah. Continuous current trials , Alternating current trials
B B.—Steam superheated to 465° Fah. Continuous current trials

FIG. 4.

* Taking the initial pressure as 115lb. per square inch absolute, the temperature of saturation is 338deg. F. Superheating to 443deg. F. makes the total energy of each pound of steam at admission 1,235 thermal units. Each pound does work equal (at full load) to about $\frac{1}{11}$th of an electrical unit; and the thermal equivalent of this is 122 thermal units. Hence, if we neglect the small loss of heat which occurs through radiation and air convection from the turbine case, steam at 100lb. pressure initially superheated to 443deg. F. will retain at exhaust a total heat of 1,113 thermal units. This makes it just saturated, for 1,113 thermal units is the total heat of 1lb. of saturated steam at the final pressure of 1lb. per square inch.

The consumption of 28lb. per unit corresponds to 20·9lb. per electrical horse power hour. To facilitate comparison with other engine trials, it may be useful to estimate from these results what may by analogy, be called the "indicated" horse power of the turbine—that is to say, the mechanical work done by the steam on the turbine blades. The curves of Fig. 7 are nearly straight lines, and by prolonging them backwards to meet the base line produced, it appears that the idle work—that is to say, the work done without useful output—was equivalent to 27 kilowatts, or 36 h.p. The effective work at full load, the equivalent of 100 electrical units per hour, was 134 e.h.p. Hence, if the idle work had the same value at full load as when the machine was running light, the total work done by the steam at full load would be 170 h.p., and the effective work, 134 h.p., would be 79 per cent. of the total. But the idle work certainly increased when the machine was loaded, and it will be nearer the truth to assume that the effective work was not more than 75 per cent. of the total work. This would make the total work about 179 h.p. On this basis, a consumption of steam at the rate of 28lb. per electrical unit is equivalent to 15·7lb. of feed water per "indicated" horse power hour, and 27lb. per unit is equivalent to 15·1lb. per "indicated" horse power hour. Similarly, the consumption of half load is equivalent to about 17lb. per indicated horse power hour.

No allowance, as has been said, was made in these trials for leakage of steam and water from the boiler. It is well known that some leakage occurs under the most favourable conditions, and that if the quantity of steam used were measured after passing through the engine—as is often done in tests where a surface condenser is used—the results would be more favourable than those obtained by direct measurement of the feed. In the present instance it appeared from separate observations that the losses by leakage amounted to about 90lb. per hour, or, say, 3 per cent. of the whole consumption in the full power trials. If this allowance were made, the quantities of steam per horse power hour and per unit would be reduced below the values stated above by about 3 per cent. in the full power trials, and by about 6 per cent. in the half power trials.

By applying the indicator at various parts of the turbine case, the range through which the pressure varies as each gust of steam passes, and the fall of pressure from one set of turbine rings to the next throughout the series, may be examined. This was done during the trials, with the result of showing that the apertures of the several turbines were not adjusted in the best possible relation to one another; in particular it was found that the turbine rings on the large disc at the condensing end gave too free a passage, and were doing less than their proper share of work. The re-adjustment of areas indicated by this test as desirable will, no doubt, secure even better results.

Apart from the other possible applications of a peculiarly light and efficient high-speed motor, the turbine dynamo in its present state is, in my opinion, eminently well fitted for central station use, not only on account of its economy of steam under both heavy and light loads, but also on account of its exceptional lightness and compactness, its small first cost, its independence of foundations, its freedom from vibration, its steady governing, its simplicity, the ease with which it is handled, and the moderate outlay which it may be expected to require under the heads of maintenance, oil, and attendance. So far as I have been able to judge, the performance of the machine is as excellent as its details are ingenious.

LEGAL INTELLIGENCE.

HOPKINSON v. THE ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY.

Mr. Hopkinson, Q.C., on Thursday in last week, with the consent of both parties to this patent action, the further hearing of which had been adjourned till Monday last, asked that the case might stand out of the list generally, with liberty to apply to restore it.

Mr. Justice Romer made the order asked for.

COMPANIES' MEETINGS.

WEST INDIA AND PANAMA TELEGRAPH COMPANY, LIMITED.

The thirty-first ordinary general meeting of this Company was held on Tuesday at Winchester House.

Mr. C. W. Earle presided, and in moving the adoption of the report stated that, although there had been a decrease of £4,762 in the receipts and an increase of £3,721 in the expenses, it was somewhat better, on the whole, than he anticipated it would be when they were discussing the effect of the reductions in the tariffs which they were compelled to make 12 months ago. He felt pretty confident that the considerable reductions made by them in their tariffs—amounting to very nearly 50 per cent. at most stations—had not produced a single extra message over their lines. When a message cost some pounds to transmit, it was not sent at all unless it was of importance, and, therefore, whether a message cost £3 or £5, the probability was that just as many messages would be sent at the one tariff as the other. The competitors who had invaded this Company's field, so very unnecessarily, as it seemed to him, must regret having expended their money in laying cables in the West Indies. The report submitted by that company at the meeting held last was a very gloomy one, and [illegible] he thought it possible that it would be still worse. They were now broken down in their line to Brazil, and although it [illegible] them very little traffic, yet he thought it would cause a great loss of time, and, if they were forced to repair [illegible] expense. At present that company had no ship on the West Indian stations for repairing purposes. With reference to their own expense on cable repairs, they had had 15 interruptions during the past half year compared with seven in the same period of the previous year, and they had used 190 knots of cable compared with 41 knots in the June half of 1891. This of course would explain the very large increase in the expenditure on cable repairs. As the repairs of the Grenada-Trinidad and Jamaica [illegible] lines amounted to renewals, they had followed the practice previously adopted in repairs of such magnitude, and [illegible] part of the cost to the reserve fund. He concluded by moving the adoption of the report.

Sir James Anderson seconded the motion.

A short discussion followed, and, in answer to questions, the **Chairman** stated that the traffic receipts in the current [illegible] showed an improvement of about £1,700 over those of last year up to the present date; and that repairs, he was glad to say, had been very much less. The Jamaica-Porto Rico line was about one-seventh of their whole cable. Even after charging the [illegible] renewals in question to the reserve fund it stood at [illegible] what it ought to be in the twenty-third year of [illegible] existence. About £7,000 of the cost of the new cable and repairs had been charged to revenue account, and [illegible] in the light, was quite a legitimate charge to the reserve fund. The cable between Jamaica and Colon, on which they obtained [illegible] any traffic, was not duplicated, but all the other cables were.

The motion was adopted.

BUSINESS NOTES.

York.—The date for the York tenders is the 21st inst.

Hove Town Hall.—The plans and tenders for wiring the Hove Town Hall are to be sent in by 18th inst.

Johnstone (N.B.)—The next meeting of the Johnstone Municipality will consider the lighting of the town.

Cars.—The cars for the Liverpool overhead electric railway are being built by Messrs. Brown, Marshalls, and Co., of B[illegible].

Bell's Asbestos Company, Limited.—The works [illegible] this Company have been removed to Southwark Bridge [illegible] Southwark-street, S.E.

Glasgow.—The Gas and Electric Lighting Committee of the Glasgow Town Council has Mr. William Ure as convener and [illegible] William Stevenson as sub-convener.

Dublin.—The new fish and vegetable market, which has been in progress of erection since March, 1891, is nearly completed. The lighting will be a mixture of electricity and gas.

Arc Light.—The great search light at the World's Fair [illegible] electric arc of 150 ampères, and the illuminating power of its beam is calculated equal to that of 100,000,000 candles.

Western and Brazilian Telegraph Company.—The receipts for the week ended November 11, after deducting 17 per cent. payable to the London Platino Brazilian Company, were [illegible].

Richmond.—The newly elected Mayor of Richmond, A[illegible] Burt, referred on taking office to the electric lighting as one of the important matters that were requiring earnest attention this year.

Totton.—Tatchbury Manor, the residence of Mr. [illegible] Wilson, C.C., is now lighted by electricity, which is also [illegible] into requisition in connection with the dairy and other parts of the premises.

Derby.—The Electric Lighting Committee of the Derby Town Council consists of Aldermen Bemrose, Hextall, L[illegible] and Woodiwiss, Councillors Bottomley, Bowring, Butterworth, Harrison, E. Haslam, and Stone.

Bristol.—Tenders for underground mains, arc lamps and posts for Bristol central station will be received until Dec. 1 by Mr. D. Travers Burges, town clerk. Forms of tender and specifications are obtainable on payment of £2.

Switch Invention.—The name of one of the inventors of the new switch we described last week which was given as [illegible] should be Husk. Mr. W. A. Husk is superintendent of public lighting to the St. Pancras Vestry.

Northampton.—The Highway and Lighting Committee of the Northampton Town Council report that, after inspecting the electric light in the Market-square, they have asked the engineer of the electric light company to send an estimate for lighting the square.

Shoreditch.—Mr. E. Manville, 39, Victoria-street, Westminster, on behalf of his firm, Messrs. Waller and Manville, has been appointed consulting engineer to the Vestry of St. Leonard, Shoreditch, to advise them on their proposed electric lighting undertaking.

City and South London Railway Company.—The receipts for the week ending November 13 were £860, against £[illegible] for the corresponding period of last year, or an increase of £[illegible]. The total receipts for 1892 show an increase of £1,533 over those for the corresponding period of 1891.

Paisley.—Tenders for the transference of their electric lighting powers are invited by the Paisley Town Council. Information by appointment from Mr. W. A. Bryson, M.I.E.E., 11, Bothwell street, Glasgow. Tenders received up to 28th inst. by Messrs. Young and Martin, town clerks, Paisley.

Liverpool.—The main construction of the Liverpool Overhead Railway is now practically finished, and the details which have yet to be attended to will take but a very short time. It is understood that the railway will be opened for traffic within the next month. As stated in our last issue, a successful run has been made.

Sugar Refinery.—J. and R. Houston, Cartburn Foundry, Greenock, have received a contract to construct buildings, plant, and machinery for a sugar refinery in the East, to be capable of producing 3,000 tons of refined sugar in a month. The works are to be fitted with all the latest improvements, including the electric light.

Fleetwood.—The Fleetwood Commissioners, having definitely decided upon a scheme of electric lighting, have appointed a committee to negotiate for the purchase of a site near Copse road, for the erection of the necessary works. The Commissioners have had before them tenders and reports from 16 electrical engineers and companies.

Weston-super-Mare.—At the last monthly meeting of the Town Commissioners the question of a company taking over the provisional order was discussed. Enquiries had been made, and the Commissioners agreed that they would consider a proposition coming from a substantial company provided the conditions offered were satisfactory.

Cambridge.—At the annual meeting of the Cambridge Town Council last week, it was resolved, on the motion of Councillor Ginn, seconded by Councillor Vinter, that the seal of the Council should be affixed to the deed of transfer of the powers of the Corporation under the Cambridge Electric Lighting Order to the Cambridge Electric Supply Company, Limited.

Accrington.—In consequence of the Accrington Gas Company having raised the price of gas by 3d. per 1,000 cubic feet, the extensive firm of Messrs. Howard and Bullough are fixing a small installation of electric light at their works with a view of dispensing with the use of gas. The moulding shop and technical school have been lighted by electricity for some time.

Scarborough.—There will be some good contracts conjoined with a lively outing for electrical men during the coming spring, if the signs of the times are correct. The Mayor of Scarborough, on his election, dwelt specially on the paramount importance to the town of the general adoption of the electric light, which it was hoped would be carried out during his term of office.

Wigan.—The following gentlemen constitute the Gas and Electric Lighting Committee of the Wigan Town Council: Mr. C. B. Holmes (chairman), John Gee (vice-chairman), the Mayor, Aldermen Ackerley, Hilton, Heywood, Richards, and Smith, and Councillors Benson, Booth, Baldsworth, Joseph Wilson, W. Rigby, Gaskell, Henderson, John Johnson, Worswick, and J. Woods.

Barnard Castle.—A committee has met the representative of the Brush Electrical Engineering Company, Mr. J. J. Hall, to receive an approximate estimate for lighting the town of Barnard Castle with electric light. Mr. Hall has made an inspection of the river with a view of utilising the water power, and the matter was discussed in detail. The Lighting Committee are expecting further particulars and plans.

Farnworth, near Bolton.—The Farnworth Local Board have appointed a committee to consider whether or not the electric light should be adopted for the town. The town is at present supplied with gas by a private company, and there have been numerous complaints from millowners and private consumers as to the bad quality of the gas. In one case the illuminating power was so bad that the mill had to be closed.

Morecambe Tramways.—The directors of the Morecambe Tramways Company report that the provisional order authorising the company to construct an additional line was confirmed by Parliament in June last. The Board of Trade declined to consent to the use of electricity as the motive power until such time as the road west of The Midland Hotel be widened. The directors propose to proceed with the construction of the line from the new pier to East View in readiness for next season's traffic.

Swan United Electric Light Company, Limited.—For the year ended September 30, 1892, the Directors have resolved, subject to audit, to recommend the shareholders to declare a dividend as follows: 4s. 2½d. per share on the 78,949 ordinary shares (£3 10s. paid), and 4s. 11½d. per share on the 19,750 £5 (fully paid) shares, free of income tax. This, together with the interim dividend paid on May 31 last, will make a total distribution of 10 per cent. for the year on the ordinary £3 10s. paid shares of the Company. The dividend will be paid upon the register as it stands this day, and the warrants will be issued on December 13.

Burton.—The Gas and Electric Committee of the Burton Town Council, in their report presented at the last meeting, announced that the gas manager, Mr. Ramsden, had produced plans of the districts to be lighted by electricity. The cost of the project was given as £25,000, and the committee recommended that application for a loan to that amount be made. In answer to a question, Alderman Lane, on the authority of the gas works manager, said that the engine at the refuse destructor was not of sufficient power to be used for the electric light. The committee were empowered to apply to the Government Board for permission to borrow the required amount.

Train Lighting.—An order for accumulators for lighting a further seven trains on the Brighton and South Coast Railway has been received by the Electrical Power Storage Company. This railway company has already 23 trains lighted, and, with the seven now in hand, will have 30, which are expected to be in use after the commencement of the year. In addition to this, their telegraph superintendent, Mr. Houghton, informs us that there is every possibility of very large extension in the near future.

Islington and Hackney.—The Islington Vestry and the Hackney District Board of Works have each given notice of an intention to make application to the Board of Trade, under the Electric Lighting Acts of 1882 and 1888, for a provisional order enabling them to produce and supply electricity and electric light for public and private purposes within their districts. Among the streets in which it is proposed to lay the electric mains, should the application be granted and the order confirmed by Parliament, are High street and Upper street, Islington; Holloway road and Seven Sisters road; High street, Kingsland; High street, Stoke Newington; Kingsland road, Mare street, Stoke Newington road, and Dalston lane.

International Electric Syndicate.—Mr. Justice Vaughan Williams, sitting in Bankruptcy in London on the 9th inst., granted a winding-up order in the case of the International Electric Syndicate, a company whose registered office is in Manchester. The petition was presented on behalf of Mr. C. H. Hodgson, a holder of 500 shares, and was granted under that section of the Companies Act which states that if a company has carried on no business within one year of the date of its incorporation it may be wound up. Moreover, it was stated that the registered offices of the company in Manchester had never been opened, and no business had been carried on.

Coatbridge.—Certain statutory notices are now running with reference to the Coatbridge installation which do not expire till the 28th inst., and during the currency of these notices nothing can be done in the way of breaking ground. The manufacture of the necessary mains is being pushed forward with all speed, and the contractors only await delivery of these and the expiry of the notices to commence work. The machinery is being built, and when completed and erected will embrace all the most modern improvements in electric lighting. The contractors intend to make the Coatbridge installation a model in all respects, and it is anticipated that the company will be able to supply electric light as cheap as the present gas.

Claybury Asylum.—The Asylums Committee of the London County Council are prepared to receive tenders for the installation of electric light at the London County Lunatic Asylum in course of erection or completion at Claybury, Woodford, Essex. Printed forms, bond, and lithographed copies of the drawings, can be obtained on application to the clerk of the committee, at the offices of the committee, 21, Whitehall place, S.W., on payment of £2, which will be returned on a bona fide tender being delivered within the appointed time, or on return of the forms and drawings before that time. Tenders must be delivered at the offices of the committee not later than noon on December 6, 1892. The contractor will have to enter into a bond in the penal sum of £300, with two approved sureties, each in £150, as security for the due performance of the contract.

Weston-super-Mare.—The Town Commissioners of Weston-super-Mare were much agitated at their last meeting on the question of electric light. It seems that a firm of accountants, Messrs. Curtis, Jenkins, and Co., of Bath, have written to know upon what terms the Commissioners will hand over their electric lighting powers. A long discussion ensued on the resolution to entertain this proposal. Desire was freely expressed that the Board should keep the matter in their own hands, Mr. Phillips proposing, and Mr. Palmer seconding a motion to this effect. Mr. Pethick, on the other hand, said there was no one on the Board who was competent to see the matter carried out, and if they did not act by June they would be in the hands of outsiders. The report of the Inspection Committee to consider the proposal of the company was finally adopted by a considerable majority.

Madrid.—According to the *Engineer*, it is proposed to build a great dam on the Guadarrama river, near Torrelodones, where a fall of about 200ft. can be obtained. This can be increased to a total of 1,100ft. by building a canal five miles in length. The power obtained will be used to run dynamos, and will be transmitted to Madrid by wire for use in lighting the city and for other purposes. To equalise the power, and provide a supply of water in the dry season, a canal some 15 miles long will be built to connect Lake Pantano with Guadarrama; the lake being thus utilised as a storage reservoir. The plan also includes the use of the water after passing the dam, and water power to supply the city of Madrid and irrigate the country surrounding it. Madrid has now a very insufficient water supply, and the new project, it is expected, will much improve its health and convenience.

Central Station Cells.—The Electric Power Storage Company have recently introduced a new central station accumulator cell, with a number of plates (total) ranging from 42 to 132, with a corresponding maximum discharge rate for one hour of from 350 up to 1,200 amperes. The new central station cells embody the following improvements: Capacity for high rates of discharge, 1,200 amperes for one hour from 61 positive plates as a maximum; lead box with insulated bottom, the plates are fitted in the box, being also provided with lip so that electrical leakage, due to creeping of acid, cannot take place; each set of plates can be separately removed without interference with the remainder or with the circuit; the

area of connections is greatly increased; the arrangement of electrodes is such that the work is uniformly distributed over the whole of the plates, even when working at emergency rates.

Heckmondwike. At the meeting of the Heckmondwike Board last week the Electric Lighting Committee reported that they had held an adjourned meeting, when the terms of a telegram previously received, offering to take 600 lights for the Heckmondwike Shoe Works, was confirmed, the offer being subject to arrangements being made for satisfactory insulation, and that the price did not exceed that quoted by the Board. No resolution was passed upon the letter. Messrs. Wood (chairman of the committee) and Macaulay were appointed to draw up replies to a number of letters from private electric lighting companies who had been written to asking upon what terms they would light the town with electricity at their own cost. The minutes were approved.

Huddersfield. The work of laying the electric mains in Huddersfield, which has been done in a careful and substantial manner, has made satisfactory progress, and is now nearly completed. There are now 2,900 yards of conduit laid for the high-tension mains, 3,550 yards of conduit laid for the low-tension mains, and 64 junction boxes have been built. The conduits for the mains have been laid in the principal streets, which, under the provisional order, form the compulsory area of the borough, and the mains are of sufficient size to meet the future requirements of consumers. The occupiers of a number of shops and offices have already applied to be connected to the electric mains. Some advantageous positions have been secured for the transformer stations, and these are now in course of erection. It is thoroughly expected that by the spring of the coming year the electric supply will be commenced.

Whitehaven. The Whitehaven Town and Harbour Trust had before them at a special meeting last week the question of electric lighting contracts and loans. The committee reported that the surveyor had been instructed to advertise for tenders for the masonry, brickwork, and concrete in engine foundations and boiler seatings in accordance with the specifications. A letter was read from the Local Government Board, enclosing formal sanction for the Trustees to borrow £14,000 for purposes of electric lighting, to be repaid within a period of 20 years, and notifying that the application to borrow an additional £7,000 should be deferred. It was agreed that the seal of the Board should be attached to contracts for electric lighting plant already approved; and on the motion of the chairman it was agreed that the £14,000 should be borrowed, the chairman remarking they would have no difficulty in obtaining it at 3½ per cent.

Electric Light in Flour Mills. Messrs. Christy Bros., electrical engineers, of Colchester, have of late been placing installations of the electric light in numerous flour mills. They are now erecting a very complete plant for 200 lights for Messrs. J. and H. Robinson, Deptford Bridge Mills, Greenwich, consisting of a slow-speed dynamo, driven by 12-h.p. gas engine, and all the latest improvements, including a large number of hand lamps of a new and improved type. They have also made important alterations and extensions in the mills of Messrs. E. Marriage and Sons, Colchester, and Messrs. Lofthouse and Hammond, of Borough Bridge. Among numerous installations in other classes of electric work, they have in hand a 400-light plant at Stockport, a 300-light plant at Maybole, in Scotland, and a large combined arc and incandescent plant in an extensive paper mill at Purfleet. They are making an entirely new application of electricity in a large clothing factory near Bath in the shape of a large number of electric "geese and irons" for ironing the garments.

London County Council. At the meeting of the London County Council on Tuesday, the Highways Committee reported, with reference to the appointment of Mr. A. E. Rosster as inspector, at a salary of £250 a year, that they considered it well for the appointment to be continued on probation until November, 1893, subject to confirmation at this date. Notices were sanctioned for laying mains by the Westminster, the House-to-House, the Kensington and Knightsbridge, and the Notting Hill Electric Companies. The St. James and Pall Mall Electric Light Company had given an emergency notice of intention to substitute armoured cable for the existing bare copper mains across Pall-mall by Waterloo-place. This the committee regarded as a very desirable alteration, and needed to be made in all cases as quickly as possible, so that they were of opinion that the action of the company in treating the matter as one of emergency is justifiable. The committee also recommended that permission be given to the General Post Office to place an additional four-wire cable in the Commercial-road subway.

Burnley. Alderman Collinge, in moving the acceptance of the tenders for electric lighting plant, which we gave last week, said the committee believed the electric lighting station would be finished during the spring, and they were desirous that the other work should be going on at the same time. By doing that they would have the electric light in such a state that anyone desiring to take it up could do so before midsummer, and prevent the great rush that might be made in the winter. The amount of the tenders was £17,700, whereas the original estimate was £19,000 and they had got powers from the Local Government Board to spend £23,000. Alderman Lancaster said the tenders were very elaborate. They had adopted a special system of cable, which ought only to be put in the bottom of the streets. In answer to questions, he said the length of the cables would be about 2,200 yards, the laying entailing a cost of £1,000 additional to the amount mentioned. The building was sufficiently large to accommodate twice the plant, and they [illegible] for further extension when needed.

Coventry.—Considerable discussion is taking place in municipal circles respecting the proposals of Mr. W. F. [illegible], the purchaser of the undertaking of the Coventry and District Tramways Company, to provide a new equipment and install [illegible] traction. The latter is on the overhead wire system, which many object to because of the narrowness of the Coventry streets. On the other hand it is contended that the system can be so modified and adapted as to practically remove all objections. The City Council have up to the present kept the matter at arm's length, some of the influential members of the body being opposed to tramways through the city under any system. The General Works Committee have appointed Alderman Marriott and Councillor Andrews a special deputation to visit Leeds and inspect the working of the system there, and they will do so next week. On Wednesday night, however, an independent party left Coventry for the same purpose—viz., Councillors [illegible] Thomas, Haywood, Webb, Worrall, Fowler, Callcott, [illegible] and Statham. They were accompanied by Mr. Seilon, [illegible] engineer.

Seaforth and Waterloo. A proposal is on foot for the establishment of a central generating station and system [illegible] supplying the electric current throughout the district of Seaforth, Waterloo, Blundellsands, and Crosby, near Liverpool. We understand that it is meeting with a very encouraging [illegible] from the residents who have as yet had the [illegible] before them. A number of gentlemen have already signified their intention of supporting the undertaking. The names include those of the chairman and several members of the two Local Boards and other prominent residents. A circular will shortly be sent round to the householders in the district pointing out the advantages of the light, and enclosing a requisition form stating about how many lights will be required in each house. The system to be adopted will be the alternating current transformer system, which enables a scattered district like the one under consideration to be served economically. The engineer for the scheme is Mr. Wilfrid S. Boult, A.M.I.C.E., 60, Castle-street, Liverpool, and the secretary, *pro tem.*, Mr. Charles Stananought, 41, [illegible] street, Liverpool.

Windermere.—At the monthly meeting of the Windermere Local Board, the chairman stated that an application from Mr. Fowkes for permission to lay an electric cable was considered by the Main Roads Committee of the County Council at their last meeting and they consented on condition that he paid [illegible] per mile per year as way leave, and undertook all risks and the leaving of the roads in proper condition. He supposed the Bowness Board had given their consent, and it only remained for the Windermere Board to do the same, upon similar terms to those granted by the County Council. Mr. Fowkes, who was present, said it was not proposed to obtain a provisional order, but to act as a private company. He would undertake to supply [illegible] terms to be mutually agreed upon. He had already made an agreement with the Bowness Local Board by which the light was to be supplied where required at the rate of 10d. per unit. [illegible] he understood the agreement with the Bowness Local Board was that the electric light should be supplied at the same [illegible] Mr. Fowkes explained that that was in respect of the public lighting only. He could not say whether they could do the same for Windermere, as he had no basis to go upon. Having [illegible] to submit the agreement made with the Bowness Board [illegible] clerk he withdrew, after which a committee, consisting of Messrs. Irving, Garnett, and Pattinson, was appointed to look into the matter, see what arrangements were likely to be suitable, and report to next meeting.

Penarth.—An adjourned meeting of the Penarth Local Board was held on Monday to consider the scheme proposed at the last meeting of lighting the town by electricity. Mr. J. Rose, engineer, of West Bute-street, Cardiff, attended and produced plans showing the principal streets to be lighted. Mr. Rose stated that a powerful company was being formed for this purpose, and should the Board grant the necessary permission, work would be commenced forthwith. He further stated that his company would be prepared to undertake the lighting of the principal thoroughfares at a charge of something under £3 per lamp per annum. In answer to a question, Mr. Rose explained that the price for private houses would not exceed the present gas charge by more than [illegible] per cent. He pointed out that if the Board decided to light the streets this price would be materially reduced. The plans of Mr. Rose were discussed by the Board and favourably received. The chairman asked whether, if the Board decided not to light the principal streets, the proposed company would still proceed with the house-to-house lighting by electricity. Mr. Rose answered in the affirmative, and stated that his principal object was to secure the sole right to carry the necessary wires through the streets. The chairman said the Board would at once consider the question. Mr. Rose then thanked the Board for their courtesy, and, in conclusion, stated the estimated capital required for the carrying out of the project would be about £15,000, and so confident was he of success that his partner and himself were prepared to find one-third of the amount. A suggestion was adopted that the clerk be instructed to apply to all towns which have adopted the system, inquiring how the scheme worked satisfactorily.

Arundel Castle.—The contract for the electric lighting of Arundel Castle, the seat of the Duke of Norfolk, which has been secured by the Brush Electrical Engineering Company, will be one of the largest and most complete private installations in the country, comprising some 1,200 lamps of 16 c.p. for the castle, together with an additional number of lights for the large [illegible] 12 50-c.p. lamps for the drive, and eight 100-c.p. for lighting the

one industry, and should be worked together in the interest of the public at large. Gas for heating can be produced for half the price of gas for lighting. Bradford and St. Pancras have been at work for some time and are making profits. Bristol, Glasgow, York, Manchester, Nottingham, Dundee, Huddersfield, Chester, Burnley, Southport, Blackpool, Portsmouth, Hull, Barnsley, Worcester, Wolverhampton, etc., are already at work; and nearly every other town of importance is either considering or has decided upon taking it up as a municipal industry. The business increases more rapidly when fostered by a corporation than by a company, for the ratepayers, being virtually the proprietors, take an interest in the progress of their own industry when they know that its profits go to the reduction of their own rates. I am sure that in two years 10,000 lamps will be taken up in Yarmouth. The Corporation itself will absorb nearly 1,000. Every hotel must take it for their own prosperity; shops, offices, and private houses follow. Now the average revenue per lamp fixed may be taken at 10s. per annum at 6d. per unit, and 10,000 lamps will produce a revenue of £5,000. The working expenses may be taken at 50 per cent. of the gross receipts, and 10,000 lamps will give a profit of £2,500 per annum to pay interest on loan, to provide sinking fund, and to pay for public lighting, or to reduce the rates. Full allowance is made in working expenses for depreciation and renewal. An electric light plant must always be maintained in perfect working order. Nothing can be allowed to decay or depreciate. I do not recommend the committee to go in for 10,000 lamps at once. I think it will be sufficient to start with smaller plant. The growth of business is easily met by the multiplication of plant. It is proposed to establish the central station at the north end of the South Denes near the Fish Wharf. No place in the whole borough can be found more suitable. Water is abundant, coal is easily delivered. Cheap and expansible buildings can be built there, and units of power can be installed, which can be multiplied as the business increases. I think it would be quite sufficient to start with a capital of £10,000, viz., building £1,500, and plant and mains £8,500. This would give us power sufficient to provide current for 4,500 35-watt lamps. The Corporation have already advertised for tenders, and several tenders have been submitted, which I have carefully examined. They vary so much, and are based on such different assumptions, that I do not recommend the acceptance of either of them, but I suggest to the committee that when the authority of the Council be obtained to expend £10,000, full detailed specifications of a definite plan be prepared upon which comparable and acceptable tenders can be invited from those who have competed. I am a great advocate of public lighting. Brilliant illumination increases the security of our streets. Accidents in large towns are relatively greater during the hours of darkness than during daylight. The amount of light distributed over the roadway by an ordinary street gas burner is very small, and the spaces halfway between the lampposts are not much advanced from darkness. Hence accidents at night are frequent. If one arc lamp replaces four gas lamps, the illumination is improved four times. These 50 arc lamps would replace 200 gas lamps, and give much better effects. Moreover, half of these lamps can be put out at midnight, and hence we find by experience that the cost of maintaining the electric light does not exceed that of gas. Four ordinary gas lamps cost in Yarmouth £13. 4s., and one arc will cost £14 per annum. Public street lighting gives all the ratepayers of the borough an interest in the undertaking. It is, moreover, a great advertisement for the electric light. It tends more than anything else to popularise the movement. Public street lighting favours all classes alike. Moreover, it must be done well, otherwise it would have the opposite effect, as has been the case in more than one instance where very imperfect street lighting was attempted. I do not advocate public street lighting at once. I think it better to start the station on a small basis to acquire experience and secure confidence. But when all is going well, then the illumination of the quays, of the Fish Wharf, of the Market place, and of the Parade and piers by arc lamps will convert Yarmouth into a place of beauty by night. Other seaside resorts will be surpassed, and the town itself will be advertised all over the United Kingdom in a way that no payment would secure."

PROVISIONAL PATENTS, 1892.

NOVEMBER 7.

19902. **An electric energy motor.** Robert Pippette, 31, Endymion road, Brixton Hill, London.

20056. **Improved electrical appliance to be adapted to clocks for giving an alarm.** Victor Durand, 9, Warwick court, Gray's inn, London.

20064. **An improved method of and means for generating currents of electricity for promoting the growth of vegetation.** Robert Henelade Courtenay, 11, Lambourne road, Clapham, London.

20065. **Improvements in the construction of horticultural buildings also with apparatus and means for forcing the growth of vegetation by electricity.** Robert Henelade Courtenay, 11, Lambourne road, Clapham, London.

NOVEMBER 8.

20100. **Improvements in and connected with telephone switches.** William Albert Shaw and Edward Arthur Shaw, 4, Corporation street, Manchester.

NOVEMBER 9.

20214. **Improvements in electrolytical apparatus.** Alfred Julius Boult, 323, High Holborn, London. (O. Knöfler and Fr. Gebauer, Germany.)

NOVEMBER 10.

20254. **Improved arc lamp for photographic purposes.** Henry Bonn and William Hafgood, 43, New Kent road, London.

20272. **An improved electric billiard marker and pool marker.** William Walter Gerard Webb, 9, Coppenhall terrace, Crewe.

20311. **The improved electric engraver.** Charles E. Braun and Frederick Wilde, 37, Oxford street, London.

20316. **Improvements in electric lighting.** Hannah Clegg, Brampton, West Norwood, Surrey.

20333. **Improvements in apparatus for protecting transformers and other electrical apparatus from lightning and from electric currents of excessive strength.** Charles Eugen Lancelot Brown, 40, Lincoln's inn fields, London.

20348. **Improved electric battery cells.** Richard John Black, 70, Deansgate, Manchester.

NOVEMBER 11.

20369. **Improvements in electric arc lamps.** Richard Albert Goodman, Commercial street, Halifax.

20371. **Automatic electrical railway signal.** Alfred George Barrell, 5, King street, Sheffield.

20445. **Improvements in electric motors.** Carl Raab, 28, Chancery lane, London.

NOVEMBER 12.

20478. **The combined automatic charging switch and cut-out.** Rupert Carryer, Queen Anne's mansions, Westminster, London.

20488. **Improvements in apparatus for closing an electric circuit by the passage of a locomotive or train over a line of railway, and recording apparatus connected therewith.** Francis William Webb and Arthur Moore Thompson, Holly Bank, Crewe.

20489. **Improvements in apparatus for sterilising and oxidising liquids by electricity.** Arnold Beaumont W[illegible], 28, Harley street, London.

20505. **Improvements in alternating-current motors.** William Lloyd Wise, 46, Lincoln's inn fields, London. (The Maschinenfabrik Oerlikon, Switzerland.)

SPECIFICATIONS PUBLISHED.

1890.

9257. **Effecting electrolytic deposit with aluminium.** [illegible] (Second edition.)

1891.

17706. **Voltmeter.** Nalder and others.

17886. **Electric meters.** Lucas.

18436. **Measuring and recording electric currents.** Goolden.

18477. **Galvanic batteries.** Schlesinger.

21143. **Electrical cut-outs.** Adams.

21250. **Phonographs.** Frank and Rosenthal.

22027. **Electric light shades, etc.** Silbersteig.

22115. **Galvanic batteries.** Thompson. (Hirsch.)

22316. **Electrical distribution.** Andrews.

22725. **Electric circuits.** Dingle and Urquhart.

1892.

1026. **Electrical incandescent lamps.** Everett.

13021. **Regulating electrically-driven mechanism.** Knight and Potter.

15258. **Telephonic switching apparatus.** Bennett.

15691. **Electric air ships.** Dall.

16461. **Secondary batteries.** Main.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	[illegible]
Brush Co.		[illegible]
— Pref.	—	[illegible]
City of London	—	[illegible]
Electric Construction	[illegible]	[illegible]
Gatti's	—	[illegible]
House to House	5	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]
London Electric Supply	[illegible]	[illegible]
Metropolitan Electric Supply	—	[illegible]
National Telephone	[illegible]	[illegible]
St. James'	—	[illegible]
Swan United	[illegible]	[illegible]
Westminster Electric	—	[illegible]

NOTES.

Appointment.—The Postmaster-General has conferred the appointment of engineer-in-chief and electrician to the Post Office upon Mr. W. H. Preece, F.R.S.

Society of Arts.—A paper will be read before the Society of Arts on the 30th inst., at 8 p.m., by Mr. Jas. Douglas, on "The Copper Resources of the United States."

Old Students' Association. — The presidential address of this association, entitled "Human Dynamics," by Mr. Ll. B. Atkinson, will be delivered at the Finsbury Technical College on November 30 at 8 p.m.

South London Railway.—The *Standard* gives vent to the complaints of correspondents on the overcrowding of the South London Electric Railway on Saturday afternoons and other times. We are pleased to see this sign of the times: it certainly shows the line is appreciated; and what suburban line, we should like to know, is not crowded at special times! All the same, as the traffic goes up the trains will have to be increased in number.

Niagara.—The large tunnel for the tail race at Niagara Falls has now been finished. The engineers expect to have the turbines and the rest of the plant ready for running in March next year. The plant will be capable of yielding 75,000 h.p., and as Buffalo is estimated to take only 45,000 h.p. at present, there will be sufficient to replace all existing engines in Buffalo, and still leave 30,000 h.p. for transmission elsewhere—Chicago possibly among the rest.

Turin.—A bold project is being brought to the practical point by two Italian engineers, MM. Aguidio and Azari, for transmission of force to Turin from a waterfall on the Italian side of Mont-Cenis, 40 miles distant. A power of 4,000 h.p., by means of four vertical turbines, is spoken of, the force to be transmitted electrically on six bare overhead copper cables to Turin, following the railway of the Susa Valley. The cost of the project is given at four million francs.

Book Received.—We are pleased to note the issue of the fifth edition of that well-known scientific classic, "A Hand-book of Electrical Testing," by H. R. Kempe (Spon and Co., London). A considerable amount of new matter has been added. Tables by Messrs. Glover and Co. have been inserted, as well as recent submarine cable data by Mr. Herbert Taylor. The work now extends to 576 pages. We have also received "Electric Shiplighting," by J. W. Urquhart (Crosby Lockwood and Son), illustrated.

Fire at Carnaby-street Station.—At 10 o'clock last Friday night several calls reached the fire brigade stations for Carnaby-street, Golden-square, and the news was speedily circulated by telephone that the basement of the premises of the St. James's Electric Light Company in that thoroughfare was on fire. Several engines were despatched to the scene, and with the aid of a hydrant the mischief was restricted to the portion of the premises in which it had originated. Much damage, however, was caused.

Electricity at Kensington.—A well-attended *conversazione* was held on the 17th inst. at the Kensington Town Hall, Lord and Lady Chelmsford receiving the guests. By invitation, some recent advances in electric lighting and cooking were illustrated by Messrs. Faraday and Son and Messrs. Crompton and Co. The first-named firm showed a series of artistic fittings, including many of the new devices for shading the over-brilliancy of the filament, while Messrs. Crompton demonstrated that elementary cooking and heating can be performed wherever the mains for lighting are available.

Anthracite.—The electrical engineer is doing his level best to obviate dust, dirt, smoke, and fog, and in so doing is acting as a veritable benefactor to humanity. But it will be some time till he can have houses heated by electric fires, and perhaps the next best thing he can do until this good time comes is to recommend and burn anthracite coal. An association for the promotion of the use of this smokeless coal is formed, with offices at 18, Parliament-street, and showrooms at 121, Regent-street, and the promoters, though working in a slightly different field, should have the goodwill of all electrical enthusiasts.

Coast Communication by Telephone. — The Admiralty have issued instructions to the Post Office authorities to connect Peterhead and Fraserburgh and the coastguard stations *en route* by means of telephone. The route of communication will be from Peterhead through St. Fergus to Rattray Head Coastguard Station, thence to Inverallochy and Cairnbulg Post Office and Coastguard Station. It is understood that public messages will be allowed between Fraserburgh and Cairnbulg, and possibly St. Fergus; but only Admiralty messages will be transmitted meantime between Peterhead and Cairnbulg.

Electric Traction in Paris.—The trials of Compagnie des Tramways at Paris with electric cars seem to have proved very satisfactory. The company has adopted accumulators of the Laurent-Cély-Sarcia system. The new cars have seats for 56 passengers, with roof seats. They have independent truck bodies, and each axle is fitted with a 15-h.p. motor. The cars, which can be run together in trains, run at eight miles an hour in Paris and 10 miles outside the fortifications. Each car is furnished with a special apparatus to derail the cars so as not to interrupt the traffic when the road is obstructed by accident. A powerful electric brake enables the car, by reversing the current, to be stopped within three yards.

Sulphide of Carbon.—The Baxeres-Torres process of producing sulphide of carbon consists, says the *Revue Industrielle*, in passing through a mass of carbon of any kind—coke, gas, carbon, etc.—brought to incandescence by a number of variable arcs, sulphur vapours produced by heating in the same apparatus some sulphurated substance—sulphur, sulphurated earths, pyrites, sulphates, particularly sulphate of baryta, sulphurated residual products, among others the brick ashes of soda. A series of arcs can be used operating simply by the high temperature produced to volatilise the sulphur, when this is possible, or by acting both by dry electrolysis and calorific effect on the product treated. The operation is for the purpose (1) of producing the isolation of the sulphur from the combination in which it is found, (2) producing the volatilisation of this sulphur when rendered free.

Bazaar Lighting.—A very successful bazaar was held last week at the Vestry Hall, Turnham Green, in aid of the funds of St. Alban's Church, Acton Green. The Dowager-Countess of Winchelsea and Nottingham, in the presence of a numerous company, performed the opening ceremony. The stalls were tastefully illuminated with incandescent lamps, the current being derived from accumulators, the whole of the electrical gear having been lent by Mr. Ronald A. Scott, M.R.I., of Acton-hill; whilst the installation was carried out by Messrs. Worthington, Leslie, Bigland, and Denny, under the supervision of Mr. Cyril Davies, all being members of the Acton Hill Engineering Works, and who kindly gave their services. Owing to a ball on the previous evening the work had to be carried out during the night. Lady Winchelsea expressed herself as

in the healthiness of the air. Whether such an arrangement would be desirable in the British Museum or not, it is certainly necessary in a place of this national importance that no complaints should arise about the ventilation, and we trust the authorities will be able to pay a little attention to the matter.

Liverpool Polytechnic Society.—The seventh meeting of the fifty-fourth session was held at the Royal Institution, Colquitt-street, on Monday evening, November 21st, Mr. Thos. L. Miller, Assoc.M.Inst.C.E., president, in the chair, when a paper on "Electric Traction" was read by Mr. Francis G. Baily, B.A., A.M.Inst E.E., of University College, Liverpool. In opening the paper, Mr. Baily gave an historical account of the application of electricity as a tractive force, and drew attention to the early attempts with primary batteries. A description of the various methods of traction by accumulators and by collectors and leads then followed, and examples were given of their application to trains, trams, 'buses, launches, tricycles, travellers, telpherage, etc. The methods of using accumulators were then dealt with, together with their advantages and cost, and the direction of future improvements pointed out. The collector method was then dealt with, and the limits to its use pointed out. Overhead collectors and the third rail were then referred to, and descriptions of various lines and results of working given. Comparison of the various methods in efficiency, convenience, and cost then followed, after which descriptions of the electric motors used and designs required were given. The methods of regulation were explained and the amount of power used was dealt with. The general advantages of electric traction were then considered, with its dangers and the precautions to be taken against breakdowns, and the paper concluded with an account of some of the new schemes proposed and a forecast of the lines of future advance.

Siemens and Halske Electrolytic Zinc Process. The process of obtaining zinc electrolytically adopted by Messrs. Siemens and Halske, has for its chief purpose the prevention of the zinc being deposited at the negative pole in a spongy form, consequent on hydrogen being also disengaged. For this purpose the electrolyte formed of a neutral or slightly acid solution of sulphate of zinc obtained in any usual manner by treatment of zinc ore, has added to it either (*a*) a weak solution of chlorine, bromine, or iodine; (*b*) a weak solution of hypochlorous or hypobromous acid; (*c*) a current of chlorine gas or bromine gas is sent into the solution; (*d*) or a soluble organic compound of chlorine or bromine is added, which, under the influence of the nascent hydrogen, can give up all or part of the haloid element, such as the chlorhydrine or bromhydrines of glycerine or certain glycols; (*e*) lastly, two or several of the reactions above-mentioned may be used. The proportion of zinc-hydrogenium or of nascent hydrogen which is produced electrolytically from the sulphate of zinc, causing the spongy deposit of metal, is relatively very weak. So that small quantities of the halogen element, or of its substitutes, are sufficient to produce a coherent deposit of zinc; and the action of the chlorine, bromine, etc., on the metal deposited at the cathode during the passage of the current is altogether negligible. At the commencement of the electrolysis a small quantity of the halogen element is added, renewing the dose from time to time, so that during the whole operation the electrolyte always presents a weak though distinct reaction. Under these conditions, instead of obtaining, especially at the commencement, a deposit of pulverulent grey metal, there is obtained from the moment of starting a coherent metallic coating of silvery-white colour and crystalline structure.

Units and Quantities.—M. Hospitalier, in an article on "Units, Dimensions, and Quantities," in *L'Industrie Electrique* recently, has the following passage: "English electrical engineers commit a fault in defining magnetic induction as the number of lines of force per square centimetre. In acting thus, a physical quantity and a unit are associated together; the product being a hybrid, neither physical quantity nor unit, whose least inconvenience is to falsify entirely right ideas of the relations between physical quantities, and to establish an inextricable confusion between the physical quantities and the units that serve them as common measures. For the same reason there only ought to enter into the definition of a unit of measure of a given quantity units of quantities which define this quantity. English electrical engineers persist, for instance, in expressing specific resistances in ohms per centimetre cube, under the pretext that the specific resistance of a substance is the resistance of a cube of 1 cm. each side between the two opposite faces. But a specific resistance cannot be measured in ohms per cm.^{3}; it is the product of a resistance by a length, and should be measured in ohms-centimetre. These general ideas are unfortunately almost always wrongly conceived, and it is for this reason that we so often see, even in the reports of the most scientific societies, speeds and accelerations in metres, specific resistances in ohms, and so forth. The International Congresses, adds M. Hospitalier, "would do a great and useful work by formulating, once for all, the general rules which should preside over definitions, for once these rules were settled, the special definitions would then only be natural, logical, and systematic consequences, of which the application could be indefinitely extended, to respond to the new needs of science and physical industries."

Electric Light Fires.—The practical organ of the fire insurance offices, the *Review*, has last week a first article on "Electric Light Fires," with practical illustrations. The article consists of examples, culled from here and there, of fires and other accidents resulting from electricity, from the Grosvenor fire to a shock from a gas and electric combination. There does not seem to be much attempt at classification, and some of the instances are amusing—thus: "Hatter's shop—arc light, iron resistance frame tampered with." It reminds one of the couplet, "Boy, gun, joy, fun; gun bust, boy dust." An interesting example is given, contrary to usual experience so often quoted, of a hosier whose goods were set fire to by an article falling on an incandescent lamp. Lest the unbelieving should revile, it is stated this happened twice. Examples introduced by "It is currently reported,' will not do for such a list. The instances ought to be well vouched for, and above reproach. The following sensible remarks are given *apropos* of pendant lamps: "There is a good deal of danger in connection with pendant incandescent lamps. The multiplicity of fine strands which constitute a pendant wire, the two wires also being so close to each other, makes it exceedingly easy for a fine filament of copper being left out of place in the holder, to set up a short circuit, burning out the fuse. Now the real danger comes in. Where the fuse is gone it is probably mended by a piece of copper wire of substantial thickness, and there you are, as the saying is." Moral: Give full instructions as to fuses, and see that they are obeyed. The *Review* also strongly advises periodical testing for leakage and continuity and for the examination of state of the fuse, switches, and all fittings. It is suggested that the inspector should particularly enquire on his visits with reference to apparent discrepancy between meter readings and number of lamps used, the abnormal destruction of lamps, or the variation of their brilliancy.

A Plea for Exactness.—Scientific progress is made by two methods of working, experimental and theoretical. The two are both potent, but are entirely different in kind—one deals with facts and the other with thoughts. The statement of experimental facts when proved and tested are true for all time, but the theories often change from one year to another. The writers of scientific text-books and technical articles do not seem to thoroughly realise this point, and their statements of what really exists or happens, and what is supposed upon theory to happen, are nearly always given with the same certitude of diction. "A piece of soft iron energised by a coil of wire connected to a battery will attract iron." This is a fact. "The ether is an imponderable substance existing everywhere" is not a fact—it is a supposed fact, invented to explain the action of light and electricity. Beginners in the study of electricity and kindred scientific subjects experience more difficulty than professors are willing to admit in differentiating actual from hypothetical facts. The text-books usually sin greatly in not discriminating, as they certainly should, between these two different kinds of statement. In electrical science the "ether" is the centre of most of these hypothetical statements; but when discussion is raging round a theory, when even the theory is firmly settled, until actual experiment can demonstrate the facts are as stated, would it not be better that the words "are supposed to" be or do this or that—or an equivalent hypothetical method of expression—should be used by all writers with a pretence for scientific exactness? The text of this plea for exactness in scientific statement has been given by a quotation in a technical journal from Prof. Oliver Lodge, whose definition of ether is given, commencing, "Ether is," but defining what the latest theories conceive ether to be. This attitude of mind runs through the whole scientific world, more particularly with the teachers, and a glance into any book on science will show many statements made as facts which are certainly theoretical only. Let us clearly recognise this difference between objective facts and the subjective reasoning from these facts, keeping in all discussions, and more especially in text-books, the two absolutely distinct.

Marseilles Electric Tramway.—The electric tramway recently established at Marseilles runs from La Cannebière to Saint-Louis. The generating station is placed in a new depôt erected by the tramway company at Lazaret. Three multitubular boilers by Naeyer evaporate 1,100 to 1,500 kilogrammes of steam per hour, driving three Hoffmann vertical compound engines, 100 h.p. each, running at 300 revolutions. Each engine drives a dynamo of 66,000 watts at 550 volts. The dynamos are two-pole compound wound, with ring armature. The engines were made by the Oerlikon Company, and the dynamos by MM. Sautter Harlé, of Paris. Two sets are sufficient for the service of 12 or 14 cars, the third being for reserve. A separate set made by Oerlikon produces light for the station. The cars were made by the tramway company. They carry inside passengers only, and have switches at each platform. Each axle is driven by a 15-h.p. motor by means of an endless screw acting on an helical wheel. The speed of the motors is 1,400 revolutions when travelling at 20 kilometres (12½ miles) an hour. The starting and stopping are easy and gradual under the action of the switch-lever. The cars are brilliantly lighted with three 16-c.p. lamps, and head lamps on each platform. The gradient of the line is very uneven, the greatest rise being 5·9 in 100 for 90 yards. At Saint-Louis there is a curve of 16 yards radius on a rise of 5 in 100. The cars pass these places at eight to twelve kilometres (5 to 7½ miles) an hour. At other points the speed does not usually rise above 14 kilometres (eight miles) an hour on account of the traffic, but at night the cars have been run at a speed of upwards of 25 kilometres (15 miles) an hour. The length of the line is six kilometres (3¾ miles), all double line except in one street. It is divided into four sections, each served by special overhead feeders. These are connected to the switchboard by an automatic cut-out, which interrupts the current in any case of breakage of the overhead wire or short circuit. The feeders are insulated in the neighbourhood of houses and telephone lines. They are supported on oil insulators. The trolley wire is carefully insulated by suspension pieces fitted with ebonite, and the carrier wires placed transversely across the public street are insulated from the poles and buildings by porcelain insulators carried on paraffined wood. The effective work at the ends of the line is over 50 per cent. of the power produced at the pulleys of the engines. The return circuit is made by the rails, and by an underground network of galvanised iron wire. The connection of rail to rail is effected by slotted rivets and copper wires. The contract has been carried out in combination by the Oerlikon and Sautter-Harlé Companies. The price of traction guaranteed is not to exceed 0·22f. (say, 2d.) per car kilometre (say, 3½d. per car mile) for a daily run of 1,200 kilometres, or 750 miles.

Lighthouse Communication.—It is very satisfactory to see the great attention which is now being paid to electric lighthouse communication. The interesting letter by Mr. W. H. Preece to the *Times*, which we reproduce in another column, was followed on the 24th by an equally interesting communication from Mr. Willoughby S. Smith, who states that before the year 1887 his father, the late Willoughby Smith, has carried out successful experiments with the object of communicating electrically through water to lighthouses or ships. When Sir Edward Birkbeck moved for a Royal Commission on the subject, the suggestion was made by Mr. Willoughby S. Smith to Admiral Sir George Richards and Mr. W. Shuter, of the Telegraph Construction and Maintenance Company, that the experiments should be repeated in order to show the practicability of such a system. Application was made to the Trinity House, and the Needles lighthouse was kindly placed at their disposal to carry out the trial. The writer continues: "With my assistant, Mr. W. P. Granville, I carried out experiments upon the original ideas and introduced certain modifications in the arrangements, with the result that constant communication has been maintained between the lighthouse and the shore in both directions since June last, the instruments being worked by the lighthouse keepers. I did not publish any statement as to this successful installation, because having practically carried out the trial for the information of the Royal Commission, I considered it would be quite time enough to speak more fully when the report had been made, which would probably include the evidence given by me on the subject. To briefly describe the arrangements at the Needles, I may say that an ordinary submarine cable has been laid in Alum Bay to within 60 yards of the Needles rock, where it terminates, with its copper conductor attached to a small anchor; the anchor is in 5½ fathoms at dead low water, and is quite free from any action of the waves. The shore end of the cable is attached to the signalling instruments, while to establish the circuit a simple earth-plate is immersed in the water close to the shore. On the lighthouse rock two strong bare wires dip into the sea about 10 yards apart; these two wires are in connection with the signalling instruments in the lighthouse. Thus, through the inter-

vening space of 60 yards of water the men on the rock can call the attention of those on shore, or *vice versâ*, by means of an electric bell, and communication can be established by means of a single Leclanché battery cell, which seems simpler than a powerful generator, to say nothing of the half mile of wire on the lighthouse rock, a thing impossible in most instances." The writer inclines to the idea that Mr. Preece has been doing work similar to that previously done in Alum Bay, but the methods appear less simple. The working of the system briefly described above has been inspected by the members of the Royal Commission, who sent from the lighthouse a message to their chairman, the Earl of Mount Edgcumbe, then at Osborne.

Cost of Electric Welding.—Mr. Frederick P. Royce in a paper read at the Buffalo Convention of the Chicago Builders' National Association, reproduced in the *Electrical World*, discusses the practical question of the comparative cost of electric and forge welding. The two important elements are labour required at the welder and necessary power to drive dynamo—the attention at the dynamo being slight. One man only is needed for light and regularly-shaped pieces. When great rapidity is necessary a boy or assistant will be required. In case of axle work two men are needed, a blacksmith and a helper turning out easily 150 sets of 1in. axles or 100 sets of 1½in. axles. In the case of light iron tires one man can easily weld 700 to 800 daily with a cheap helper to carry. In the case of steel tires 400 to 500 can be welded. In heavy wagon tires more help is needed. At the Studebaker works two electric welders are placed side by side, with a steam hammer near, and a force of five men turn out a large product. Step-irons, carriage rails, dash-irons, and similar work is done by one man. The removal of the burr at the joint is an element of cost. Grinding is too slow, and rolling is impracticable. Hammering has been found to be the cheapest and most effective. All welds retain sufficient heat to be hammered, and this also improves the weld. With ordinary work the light hand-hammer is most effective. Presses have also been found efficient. Cleaning the metal before welding has been abandoned, it being cheaper to use more current. When a heavy oxide is formed it is removed by pickling, but it is only necessary in exceptional cases. The question of actual horse-power required for welding both axles and tires has been most carefully considered, and the following figures are based on actual experience in various works and from very careful electrical and mechanical tests made by reliable experts.

1 in. round	axle requires	25	b.p.	for	45	seconds.
1 in. square	,, ,,	30	,,		48	,,
1¼in. round	,, ,,	35	,,		60	,,
1¼in. square	,, ,,	40	,,		70	,,
2 in. round	,, ,,	75	,,		95	,,
2 in. square	,, ,,	90	,,		100	,,

The slightly increased time and power required for welding the square axle is not only due to the extra metal in it, but in part to the care which it is best to use to secure a perfect alignment for the welding. For tire welding the figures are:

1 in. × $\frac{5}{16}$in.	tire requires	11	h.p.	for	15	seconds.
1¼in. × ⅜in.	,, ,,	23	,,		25	,,
1½in. × ⅜in.	,, ,,	20	,,		30	,,
1½in. × ½in.	,, ,,	23	,,		40	,,
2 in. × ½in.	,, ,,	29	,,		55	,,
2 in. × ¾in.	,, ,,	42	,,		62	,,

The time above given for welding is, of course, that required for the actual application of the current only, and does not include that consumed by placing the axles or tires in the machine, the removal of the upset, and other finishing processes. From the data thus submitted, the cost of welding can be readily figured for any locality where the price of fuel and cost of labour are known.

Mason College Engineering Society.—A general meeting of the above society was held in Mason College, Birmingham, last week, when a paper on "Electromotors in Factories" was read by Mr R. H. Housman. The author divided factories into two classes—(1) those in which power could be supplied from a single engine, as in a Lancashire cotton mill; (2) those in which the machinery requiring power was too scattered to enable one engine to economically drive the whole, by means of ropes and gearing. In the second case a considerable number of methods of driving might be discussed. Separate engines might be used supplied from either a battery of boilers, or each from its own; but here a loss of economy is experienced owing to condensation of steam in steam-pipes, use of smaller engines, and many other causes. He then considered the degree of economy attainable when one or more large engines were employed to drive dynamos, the current being distributed by copper conductors to motors at the various places requiring power. He pointed out that at first sight a dynamo, conductor, and motor seemed a rather expensive type of coupling, but it must be remembered that with this system of distribution it made very little difference whether the power were scattered or concentrated. In order to obtain a high standard of economy in this system it was necessary (1) that the generating plant be concentrated at a single centre, in order to economise labour; (2) the plant should be worked at or near its full capacity. For this latter reason it was often necessary to depart from the ideal system of one large engine and generator, and use several smaller engines and dynamos, the best number to be employed depending on the variation of load caused by the special work which has to be done in the factory. He next considered the amount of variation of load allowable in various cases. In the case of an engineer's machine-shop the ratio of maximum to minimum load might be taken as 3 to 1; but in some cases, where very sudden variations of load were experienced, as in rolling mills, the ratio might rise as high as 20 to 1. The advantages of the use of heavy flywheels for dealing with load variations was pointed out, but a more perfect though less simple method was to use a battery of secondary cells in parallel with the generating dynamo. The next point considered was the efficiency of the motors. The author's experience gave 94 per cent., 91 per cent., and 83½ per cent. efficiency as averages for full, half, and quarter loads. The author alluded to the series of experiments carried out by Mr. Willans, which gave a complete key to steam engine efficiency under varying loads, and showed the disastrous effect of underloading, especially with simple non-condensing engines. Electromotors suffered much less in efficiency when partially loaded, it being possible with care to obtain 70 per cent. of the steam engine indicated horse-power as brake horse-power at the motor shaft, this showing about 30 per cent. in the double conversion and transmission. In the motors used for factory purposes it was necessary that the motor should run without requiring special attention, and should not spark with variation of load. The use of carbon brushes obviates this. Another difficulty encountered was the high speed at which motors were run. This, however, could be got over by using multipolar machines. The paper was followed by a discussion, in which Messrs. R. Richardson, F. W. E. Jones, E. C. R. Marks, T. Archer, H. M. Waynforth, and Prof. R. H. Smith took part; and the proceedings terminated with a vote of thanks to the author.

PRACTICAL INSTRUMENTS FOR THE MEASUREMENT OF ELECTRICITY.

BY J. T. NIBLETT AND J. T. EWEN, B.SC.

X.

(Continued from page 509.)

RESISTANCE, *continued.*

Other Forms of Wheatstone's Bridge.—Another arrangement of the rectangular pattern of Wheatstone's Bridge, made by Messrs. Queen and Co., of Philadelphia, and differing but slightly in general principle from Dr. Muirhead's design, although varying considerably in point of mechanical construction, is shown in Fig. 23.

FIG. 23.—Wheatstone's Bridge, Queen's Pattern.

In this instrument each set of coils in the variable known resistance has its junction-pieces arranged on one side only of the long metallic bar, instead of on both sides, as in instruments of Dr. Muirhead's pattern. The chief feature in the instrument, however, is the arrangement of the coils in the two ratios, which are so devised that with three coils in each arm, there are obtained all the variations usual with four coils in each. This is accomplished by making the coils in the two arms of different values, and providing a reversing arrangement, so that the virtual positions of the two arms may be interchanged. In the example shown, the resistances of the coils in the two arms are respectively:

1,000, 100, 10,
and 100, 10, 1 Ohms,

and the reversing arrangement, the principle of which will be readily understood from the figure, is a very simple

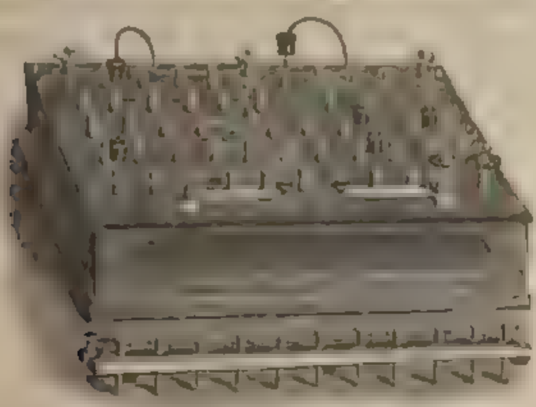


FIG. 24.—Wheatstone's Bridge, Paul's Laboratory Pattern.

one, the operation of interchanging the positions of the two ratios consisting merely in the alteration of only two plugs. Of the six terminals shown in the illustration, the two on the right hand side are for the galvanometer, and the two outer ones at the left hand side are for the battery, the unknown resistance being connected to the two inner terminals at the left hand side. It will be observed that, in this example as well as in the three succeeding ones, the galvanometer and battery keys are incorporated in the instrument itself.

Two examples of another form of combined Wheatstone's Bridge and resistance box, of the same type as the preceding ones but possessing several important modifications, are illustrated in Figs. 24 and 25. In these examples, due to Mr. R. B. Paul, the junction pieces of the coils consist of round metal sockets arranged in rows on the ebonite baseboard, and connection is made to them by means of flexible insulated conductors, one for each group or row of coils. Each of these flexible conductors has one of its ends permanently attached to the first coil of one of the rows, whilst the free end is provided with a taper plug for insertion into any of the sockets in the junction pieces in the next row of coils, contact in this way being established between two rows of coils by means of the flexible conductor. These

FIG. 25.—Wheatstone's Bridge, Paul's Portable Pattern.

these flexible conductors, each of which consists of from two hundred to three hundred strands of fine copper wire, fulfil the same function as does the round or oblong centre-piece in the dial or rectangular forms of the instrument. In both of the examples shown, Figs. 24 and 25, the underboard connections are indicated by white lines on the baseboard, so that no difficulty need be experienced in connecting up, or using the instrument. Among the advantages claimed for this form of instrument are: Surface leakage across the ebonite baseboard is reduced to a minimum owing to the junction pieces being some little distance apart, and these are easily cleaned; contact resistance is constant and easily measured and allowed for; much better contacts are

FIG. 26.—Wheatstone's Bridge, Swinburne's Pattern.

obtained as the plugs bear on the sockets all round instead of only on a portion of their circumferences. The sockets being made each in one piece are not liable to deformation through unequal expansion of metal and ebonite, as in the ordinary form of instrument; and the plugs being permanently attached to the instrument are not liable to get lost or mislaid.

The instrument illustrated in Fig. 24 is also provided with a special contact-bar as shown in the illustration, whereby any number of coils in a group may be coupled up in parallel, thus converting the instrument into a high range conductivity box, suitable for the measurement of very low resistances. The construction and principles of

mentioned, animal electricity, as the torpedo, gymnotus, and other electric fish. Lastly, there is atmospheric electricity.

Of the four practical generators of electricity—namely, the Primary cell, the Thermopile, the Dynamo and the Secondary cell—the last must be disregarded, because in the present way in which secondary cells are made, electrical energy has first to be put into them, and so converted into chemical energy, before they can be utilised to give out electrical energy. Concerning the primary cell, this is too expensive and impracticable, as shown in the paragraph on "Sources of Power." As for thermopiles, attempts have been made to construct these on a large scale, so as to make them powerful enough to run electric lights, but so far they are not classed as being of practical use. It is possible that in the future better things may be expected of this source of electricity, and it is interesting to note that, by means of a thermopile, an example is afforded of generating electricity direct from heat, and hence from burning coal, without any intervening converters. To what extent this will become practicable, it is impossible to say; the subject is, however, worth research.

Having disposed of three, we thus have only one practical source of electricity available from which to obtain electric light and power on a large and commercial scale, and that is the "Dynamo."

Water Analogy.—The simple laws regulating the flow of electricity along a conductor can best be made clear and comprehensible by comparing them with those regulating the flow of water in pipes. It must, however, be remembered that the analogy between electricity and water cannot be strained and carried too far. This water analogy is a time-honoured one, and although modern theories and speculations concerning the nature of electricity and its attendant laws, as taught to-day, are different to what were taught in the old schools, yet, for all we know respecting what electricity is, the water analogy still holds good.

In the case of water a flow is produced by a difference of level, consequently a head is created; the greater the head or pressure the quicker the flow, and the greater will be the quantity of water that will flow through the conveying pipe. By decreasing the diameter of the pipe more resistance will be offered to the flow and by increasing the diameter less will be offered; the pressure of the water, and hence its velocity, will gradually fall off along the length of the pipe, and if the pipe be made very long the pressure will be reduced so much that the water at the far end will scarcely move along. We will now see how this can be applied to electricity flowing along a wire.

1. The pressure or difference of level of the water may be likened to the E.M.F., or "Difference of Potentials," that tends to move electricity; the greater this is, the greater is the flow of electricity.

2. The size or diameter of the pipe may be likened to the diameter of the conducting path or circuit. Water flowing in a pipe produces friction, and hence heat, and this is energy wasted, so a current of electricity flowing along a wire, or other conducting path, produces what may be termed electrical friction, and this also produces heat, and hence wasted energy; by making the conducting path of greater capacity, say, by increasing the diameter of the wire that forms the circuit, a greater current of electricity will flow.

3. The lengthening of the pipe may be likened to the lengthening of the conducting path or circuit: if the wire composing the circuit be made very long, the electrical potential will fall along the circuit. In the case of water the effect of a long pipe means that a great quantity flows by at the beginning of the pipe, while scarcely any flows by at the end; in the case of electricity this does not hold, for the effect of a long circuit on the flow of current is that very little current will flow, and that, however much it is, the amount of current that flows is the *same quantity passing at every point of the circuit*.

4. In the case of water, the effect of having a pipe of varying size or diameter at various points, is that at those points where the diameter is small only a small quantity of water can get through at a time, while at those points where the diameter is large a large quantity can pass; but when the pipe narrows the velocity increases, and when it widens the velocity decreases; consequently, the product of the sectional area and the velocity at any point will be constant. Now, in the case of electricity, as already stated, the current is always the same at every point in the circuit, and the effect of having the conducting path narrow at some points and wide at others would not cause the current to vary at these points. What would take place is this: At the narrow points more heat would be generated by the flow of current, and at the wide points less heat would be generated.

5. Water, to be carried a long distance, must have very great pressure, and the quantity must be necessarily small, hence a long thin pipe of small diameter must be used.

Electricity, to be carried a long distance, must have very great E.M.F., and the quantity must be necessarily small, hence a long thin wire of small diameter must be used.

In a water system, the initial or maximum pressure decreases as the water flows on, and in an electrical system or circuit, the initial or maximum electrical potential also decreases as the current flows along the conducting path. In each case this is owing to the resistance that is met with; and the "difference of pressure" and "difference of potential" that exists between any two points of the two systems measures the loss of pressure or potential, or the amount that is absorbed in forcing the water or electric current through the distance between these two points, and so overcoming the mechanical or electric friction for that distance.

Water is a material body, whilst electricity is looked upon as a peculiar state or condition of matter—what, we do not know. We even do not know in which direction a current of electricity really flows, although for convenience it is arbitrarily assumed that it flows from the point of higher potential to the point of lower potential. Furthermore, we do not know that its action is propagated inside the wire or not; to every appearance its action takes place around the wire or conducting path, and the wire may be looked upon, not for the purpose of carrying the current, but of guiding it.

In a simple electric circuit there can only be one electromotive force, and this is called the initial or maximum difference of potentials; but there can be an infinite number of difference of potentials. For example, a battery may have an E.M.F. of 50 volts—that means the maximum difference of potential is 50 volts—and allowing the current to flow from the positive plate to the negative, the potential will gradually fall all the way around the circuit, beginning at the positive plate and ending at the negative; so that any two points in the circuit will represent a difference of potentials in proportion to the distance between, provided that the resistance of the external circuit is uniform throughout.

Electrical Units.—The practical unit of E.M.F. is named the volt, and is that amount of electrical pressure that will force a current of one ampere through a path having the resistance of one ohm. Volts are usually denoted by the letter E. Since the E.M.F. may also be looked upon as the maximum difference of potential in a circuit, hence the volt is the unit of difference of potential. Measured in absolute, or C.G.S. units, the unit signifies that E.M.F., or difference of potential, which is necessary to force a unit quantity of electricity per second from the point of higher potential to the point of lower potential, so that the current does one erg of work per second. This can be made clearer by referring to our water analogy. When a certain mass of water falls from a higher level to a lower level, then work is done by the mass; so that 10lb. falling 10ft. will do 100 foot-pounds of work. Similarly, when 10 units of current flow from a potential of 90 to a potential of 80, or through a difference of potential of 10 units, then 100 ergs of work per second have been done by the current. Also one erg of work is done by forcing a unit current through unit resistance because it requires unit difference of potential to do this, and because the amount of work that is expended in doing this—namely one erg—is evidently equal to the amount of work—one erg—done by the current. This absolute unit of potential difference is far too small for

practical purposes, hence the practical unit of potential difference, or E.M.F.—namely the volt—is fixed equal to 10^8, or 100,000,000 times the absolute unit.

The practical unit of current is called the ampere, after Ampere, a French physicist, and is that current which one volt will force through a resistance of one ohm. The absolute unit of current has a value of 10 C.G.S. units, and is too large, so the practical unit, the ampere, is equivalent to one-tenth of the absolute unit, and is generally denoted by the letter C.

The practical unit of resistance, denoted by the letter R, is named the ohm, after Ohm, the famous German physicist, who discovered the elementary law connecting pressure, current, and resistance, and is that resistance which when acted upon by a difference of potential of one volt will permit a current of one ampere to flow through it. The absolute unit of resistance is too small, so the practical unit, the ohm, is made equal to 10^9, or 1,000,000,000 times the absolute unit, and according to the Paris Congress of 1884 the ohm is the resistance of a column of pure mercury, one square millimetre (or ·0016 square inch) in sectional area, and 106 centimetres (or 41·73in.) in length, measured at the temperature of melting ice.

Ohm's Law.—The amount of current which will flow in an electrical circuit depends on the E.M.F., which urges the flow, and on the resistance of the material forming the circuit, which tends to obstruct or oppose this flow.

The flow of current is in proportion to the E.M.F., therefore the greater the E.M.F. the greater the flow; it is also in inverse proportion to the resistance, so that the greater the resistance the less will be the flow of current; hence we have

$$\text{Current} \propto \text{E.M.F.}$$

$$\text{Current} \propto \frac{1}{\text{Resistance}}.$$

Combining these two facts together, it is evident that

$$\text{Current} \propto \frac{\text{E.M.F.}}{\text{Resistance}};$$

hence we may say that the current flowing in a circuit is obtained by dividing the E.M.F. by the resistance,

$$\text{or,} \qquad \text{Current} = \frac{\text{Electromotive Force}}{\text{Resistance}},$$

$$\text{or,} \qquad \text{Amperes} = \frac{\text{Volts}}{\text{Ohms}}, \text{ or } C = \frac{E}{R}.$$

By multiplying the resistance of a circuit by the current, we obtain the E.M.F. necessary to force that current through that resistance, or E.M.F. = current × resistance, or volts = amperes × ohms, or E = C × R. By dividing the E.M.F. by the strength of current flowing in the circuit we obtain the resistance of the circuit,

$$\text{or,} \qquad \text{Resistance} = \frac{\text{Electromotive Force}}{\text{Current}};$$

$$\text{or,} \qquad \text{Ohms} = \frac{\text{Volts}}{\text{Amperes}}, \text{ or } R = \frac{E}{C}.$$

The above is known as Ohm's law, and it is the fundamental law of electricity, since it establishes the relation between E.M.F. and current and resistance.

Currents are divided into several kinds, according to the construction of the electric machine which generates them, such as continuous currents, alternating currents, pulsating currents, multiphase currents, etc.—each of these will be treated with and explained later on. For the present it suffices to say that the first kind—namely, continuous currents—are known as steady currents, because the effective E.M.F. producing them is practically constant in value, but the rest are unsteady, because the E.M.F. is constantly varying or falling and rising in value. Ohm's law, in its above simple form, is absolutely true for all steady currents, and we have every reason to believe that it is true for all unsteady currents as well, but when applied to unsteady currents, say, for example to an alternating current, then the flow of current in amperes cannot be found by simply dividing the volts of pressure by the pure ohmic resistance of the wire carrying the current, because the effect of the pressure constantly varying is to produce currents of a secondary and tertiary nature arising from self induction and mutual induction, etc. In addition to this, an alternating current flows first in one direction and then in the opposite, alternately, a great number of times per second. This brings in more complications, because the flow of current offers a certain opposition to change of direction, which is named the inertia of the current, in comparison with the inertia in mechanics. All these disturbing elements must be recognised, and, if possible, be subjected to calculation. It need scarcely be said that when this is done the complicated formula that would be presented would probably be such that Ohm's law in its simple form would be almost lost to sight; so that when Ohm's law is applied, it must be understood that it is only used for steady currents, except when otherwise stated. For those that are interested in this matter, see the *Electrical Review* of May 20, 1892, page 626.

(To be continued.)

THE INSTITUTION DINNER.

The annual dinner of the Institution was held at the Criterion Restaurant on Friday evening last, and was attended by a large number of members and guests. Prof. W. E. Ayrton, F.R.S., the President, was in the chair, and was surrounded by a distinguished company of politicians and scientists. The toast list was short, as were the majority of speakers. We have seen Prof. Ayrton in a great many characters, but we think in none has he ever shone more conspicuously than in these after-dinner remarks. They were full of point and full of wit, with the true ring of enthusiasm for the science he so admirably represented, running through from beginning to end.

The toast of "The Queen" was given and received in the usual loyal manner. The next toast, "The Learned Societies," was proposed by the President, who said that some difficulty had been felt in the wording of the toast list. It was thought that to have two toasts—"The Learned Societies," "The Engineering Societies"—might suggest that the latter were not learned. But the inference would be entirely wrong. There was no "and" in the matter. His friend Mr Macrory, as a lawyer, would tell them that the French saying "None but fools and Englishmen travel first class," was evidence that Englishmen were not fools. The presence of the conjunction made all the difference.

Prof. FITZGERALD responded in a partly humorous and partly grave speech. In the former he gave an admirable description of a discussion between two Irish car drivers as to the merits of scientific men which ended in "going for a drink." He said that the learned societies were never more flourishing than they were now. The co-operation of theory and practice had been the fruitful parent of nearly all the advances of the present generation. We had such enormous stores of energy at our service that almost immeasurable prospects were open for the material improvement of man's estate.

Mr. LATIMER CLARK (past president) proposed "The Engineering Societies." He said these societies were in danger of being overlooked. They first perfected the steam engine, then improved manufacturing implements, then the steamboat. The engineering societies had done much more to promote the great prosperity of this country than the politicians who had so wickedly usurped the greater part of the credit. The great majority, unfortunately, of our countrymen believed that this prosperity was mainly due to the politicians who attributed everything to free trade. It was to the engineers more than to any other body due that this country was the richest in the world.

Dr. W. ANDERSON, president of the Mechanical Engineers, responded, and said if the engineering societies were

not learned they had the happy gift of appropriating for practical purposes the learning of others. The Government factories, of which he was the head, could speak to the way in which the labours of the chemist and metallurgist and other scientific men were utilised to practical purposes to the great benefit of this country, and, it was to be hoped, the destruction of any country which should be so ill advised as to become involved in war with Great Britain.

The CHAIRMAN then proposed "Our Guests," with which he joined the name of Mr. Mundella, President of the Board of Trade, who exercised a sort of parental supervision over them all. No doubt sometimes there was a little disposition to grumble, as children did occasionally, at the form in which that fatherly affection displayed itself. But whatever their feelings about the Board of Trade, there was no doubt about their feelings with respect to its president. The man who by the Electric Lighting Act, 1888, made electric lighting commercially practicable was entitled to their warmest regard.

Mr. MUNDELLA, in response, said that whatever grievances the engineers might have against the politicians his withers were unwrung. The Board of Trade might have given the electrical engineers some trouble; if so, it was not due to him. He was only newly installed—only three months—and some of them might think he would not last much longer. The President had thanked him for what he had done in 1888. But he was not then President of the Board of Trade. He had, however, learnt that the Act of 1882 was too restrictive and required relaxation. But they had not suffered much from the Act of 1882, which was probably only a blessing in disguise, as it had enabled the engineers to perfect their methods in a manner which could not have been done before. Mr. Latimer Clark had complained of the appropriation of all the credit of material progress by the politicians. Let them halve the difference. The politicians had, at all events, appointed Dr. Anderson. The improvements to which Dr. Anderson had referred related to the destruction rather than the conservation of human life. But, whatever they were, the British Navy had availed itself of all those appliances, and had been enabled—we hoped for defence and not for attack—to perfect the methods of naval warfare more than any other nation in the world. Free trade was due to Sir R. Peel more than to any other man, and it was due to him that the energies of Watt, Arkwright, and our other great engineers had enjoyed free play for their energies. He was speaking to a comparatively young institution, but it was to one which was growing more and more and would advance to still greater degrees of greatness. The Board of Trade owed much to the electrical engineers, who had devised systems and methods of the utmost value. It would be his duty to embody the report of the committee with respect to electrical standards in a statement to the Queen. For that report they were much indebted to the society, as they were also indebted to the distinguished German men of science who had so greatly advanced our knowledge of electricity. But, as it would be his duty to submit to the House of Commons and the Queen the result of the labours of that committee, he could not do better than read it to them. It was in one sentence, without punctuation, and ran as follows: "That an alternating current of one ampere shall mean a current such that the square root of the time average of the square of its strength at each instant in amperes is unity." He had asked Sir Thomas Blomefield to explain that proposition, but that candid gentleman had admitted that he knew nothing about it. Sir Courtenay Boyle was not so candid, but he suspected that his friend Sir C. Boyle knew just as much as his colleague. He had been thanked for the Act of 1888. He believed we were now at the outset of a great advance in the science of electric lighting. Progress would be assured when they could assure shareholders of a reasonable dividend. Two millions had already been expended in the metropolis, and we might soon hope to overtake the United States and continental countries, which were, he feared, still, to some extent, in advance of ourselves. He hoped we should soon see the day when electricity would be the great motive power in all the work done by the nation. A marvellous change had been wrought by the introduction of the electric cable. When he left business 20 years ago, they had to wait replies for letters from Australia for three or four months. But now in one day all the operations could be carried through which used to require months to effect. Time and space had been annihilated. Electricity was now being used for the saving of life at sea, and Mr. Preece, one of their members, had been appointed a member of the Commission on Electric Communication with Lighthouses and Lightships. The number of lives lost in our electric systems had, he believed, only been six, an infinitesimal number compared with the loss which had been sustained in America. We had proceeded on a sound and careful system, which was economical of life, but would not fail to attain the greatest results at which it was possible to arrive. The Board of Trade had no desire to hamper the progress of electricity by needless rules, and hoped that in this, as in all other branches, science would go on its beneficent course untrammelled by any unnecessary regulations.

SIR JAMES SIVEWRIGHT, Commissioner of Public Works, Cape Colony, proposed "The Institution of Electrical Engineers." He spoke as one of the oldest members and a whilom secretary of the Institution, and described the affection towards the society the many members resident in the colony had towards it. He referred at length to the telegraphic work of the colony, which he half hoped and expected would continue to be pushed further and further into Africa, till its northern end reached Cairo. Parodying the words of the late MacDonald, he said his earlier life was spent as a telegraphic engineer, and his end should find him a member of the society, though, for the moment, he was under an eclipse, and so an outsider. He was enthusiastic in his expression of success to the Institution, and prophesied that the Institution would grow in strength and renown, and last as long as England lasted.

The PRESIDENT, who responded, said Mr. Mundella had made some joking remarks about the alternating definition of an ampere—it lacks punctuation, he says. Well, the reason is quite simple: it is a legal definition; and law processes are interminable, the law is everlasting, the law never stops. But he was no lawyer, so would come to an end, and thank them for the candid way in which they have drunk the toast so laudably proposed by Sir James Sivewright.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE NEW WESTINGHOUSE LAMP.

SIR,—It is an old saying that "necessity is the mother of invention," and, according to a description of the new Westinghouse lamp which has appeared in the technical Press, it is evident the experts of the Westinghouse Company have revived this ancient problem. And the advent of this new lamp, coming as it does just at this juncture, is one of great importance to all of us engaged in the electric lighting industry, not only in America, but in England and several other markets throughout the world wherever monopoly exists—in all of which places a reliable and cheap lamp cannot fail to command a ready sale amongst consumers, and by this means increase the demand for all classes of electrical plant. Therefore, this lamp opens up quite a new field for business, and, as constructed, it can be freely sold and used without fear of molestation from headquarters under the guise of the monopoly of Edison's patent rights covering certain claims to both lamps and holders, which actual infringements I have always maintained never had any real existence, except in the eyes of the law, and, singular to say, even on this point the views of various judges have very widely differed upon analysing the evidence placed before them in the various tribunals and sections of the Courts of England, Germany, and America. In England, for

instance, as is well known, the case was won and maintained in two actions entirely by infringements of the "Sawyer-Mann" hydrocarbon flashing process, which system the Edison and Swan Company cleverly secured, maintained, and worked in combination with Mr. Swan's latest improvements, which combined process undoubtedly enabled English lampmakers to produce and supply probably some of the best and most reliable incandescent lamps in the world. And so thought the German Courts, when they refused to give a monopoly to the owners of the Edison system in Germany. Now, having been professionally engaged in the litigation, both in England, Germany, and America, I have had special opportunities to peruse the evidence and pleadings used in each country, and I must say the tactics adopted by the Swan and Khotinsky people in Germany were sound. What did they do? They proved that Edison's early patents were unworkable without in some form or other by making lamps under the improvements and methods discovered at various dates by Sawyer, Mann Maxim, Weston, Swan, Khotinsky and others, which combination of talent, the German experts argued, gave to the world the real knowledge of how to make the modern glow lamp of the present time. And upon this basis the case was decided. The German lawyers are frequently called hard headed, but in the "incandescent lamp war" I am inclined to think they showed sound judgment, good stratagem, and a great deal of common sense in dismissing the German Edison Company's claims to a monopoly of the trade in Germany, which decision was undoubtedly a just and correct one and worthy of admiration from a legal point of view. If I remember rightly, one of the strongest points urged by the defenders in the German action was that the Edison Company *did not and could not* make a so called Edison lamp without adopting the more modern methods invented by others, and probably if the same tact and legal pleadings had been adopted and resorted to in England and America, both countries would have been able to have shaken hands with Germany over a triple defeat. And if all we hear and read in the Press be true, probably no man in the world was more astonished than Mr Edison (in the face of facts) to find himself legally declared by law "the inventor of the modern glow lamp," which very naturally he now believes himself to be. As regards myself, I think I can safely say that there is no man in the world as an incandescent lamp manufacturer who has personally suffered more than myself through my humble endeavours to produce a reliable low-resistance lamp for battery lighting purposes, which I claim to have accomplished by methods which in no way are infringment of others' rights; and I don't think the 60,000 little lamps sold by me during the four years I was engaged in the lamp industry did much harm, but, on the contrary, I claim my work did much good by the seeds sown, which work greatly assisted a very important industry of which the larger firms are now reaping the benefits. I also invented, as is well known, the fundamental patents for fancy and ornamental lamps, now so largely used for decorative lighting and illumination purposes -things which the great inventor did not do, as his entire group of patents show, and yet by the construction and twisting of our modern patent laws as now framed, declare and decide against me because somebody else invented something else of a colourable nature. It may be legally "law," but I fail to see where the justice comes in. I naturally feel somewhat strongly upon this point, as others are reaping the benefit without payment of a cent, and unfortunately all one can do is twinge and bear it. At the same time I do not blame Mr. Edison taking all that the law has given him; but I do blame the construction of the present laws, which as now constructed according to modern theory are neither civil, spiritual, or Mosaical, but which are so framed to provide for the upkeep of a select few Q.C.'s and certain professional experts who cling about their garments—all of whom grow fat on disputed patents. But reverting to the merits of the new lamp and its construction, which has many good points about it:

1. There is no brass used at the base, a very good point gained, as all metal contacts retain heat, which is well known to be a great objection to the construction of screw-capped lamps.

2. No platinum is used for the leading-in wires. This is another great advantage, calculating the cost of this commodity, the non use of which must cheapen the cost of manufacture, and, above all, legally overcome an important claim relative to the use of platinum.

3. The new lamp being a separable one, certain special parts, such as bulbs, sockets, and connectors, which in many cases can be reused over and over again; therefore old and hitherto useless lamp materials can now be converted into new lamps, and thus made to do treble work at a very small cost by remaking same (over first outlay paid for raw material). I can doubly appreciate this idea, especially as I hold the original and fundamental patents for converting old lamp material into new lamps under British patent granted me in the year 1887, for which method I have patents pending in the United States, and for which original process of manufacture I claim to be the first inventor; and I venture to say, according to recent decisions, that this process is a useful one, as it will enable lampmakers to convert old and waste lamp materials into an article of commercial value, and as royalties have been paid upon these used-up lamp materials, the question of infringement of the rights of A, B, and C, either in England or abroad, does not apply in the face of the many decisions already recorded, hence the value to those holding licenses to manufacture under my original patents, No. 5,955, of 1883, and No. 11,802, of 1887.

4. The question of exhausting or extracting the air from the bulb, whether it be before or after sealing, is of no moment, as such methods are old; therefore open to the Westinghouse Company or any other lampmaker to use as incandescent lamps for producing light in vacuo where made and sold by De Changy, Staite, Roberts, Harrison, Lane Fox, and others long prior to Edison's application. Therefore no further comment on this point is needed.

5. The question as to time taken up in cleaning the old bulbs when in a blackened state, upon which the *Western Electrician* lays some stress: I would also say this part of the process is a very simple and easy matter to overcome, and it can be quickly and easily done by a special method by those "in the know."

Probably the most important point to consider in the new lamp is the stopper connection, but as this is tightly enclosed and embedded in a special cement within the bulb, which is afterwards covered as an additional protection, thus making it a multiple double vacuous chamber, there appears to be no reason why a good lamp of this class (if properly constructed) cannot be made to do good work and even if not quite up to the standard of a highly vacuous lamp, the new Westinghouse type can be cheaply made; besides, the first cost materials can be used over again, and as platinum is dispensed with another good point is gained. Nor does this new lamp require any expensive socket to hold it. There is also another saving. But, above all, it is a type of lamp which is absolutely free from infringement of the Edison and Swan combination claims, consequently it is certain to sell, and it is to be hoped that the Westinghouse Company will see its way clear to supply the English market with this new type of lamp; and if sold at American prices in the country, or anything under 1s. 6d. per lamp, it will then come cheaper to use, even if the life is only half as long, and for the next year or two pending the expiry of the chief lamp and holder patents, it cannot fail to find a ready market, and at the price should command a large sale. I think every reader of your journal will join with me in wishing the Westinghouse Company all the success it deserves in overcoming a difficulty by placing upon the market a lamp which is novel in construction, natty in appearance, cheap in price, and, above all, entirely free from the combination claims of certain master patents, the working of which has been unfortunately so detrimental to the real advancement of the electric lighting industry. However, as soon as lamps become cheaper, trade in plant and machinery will increase tenfold in all parts of the kingdom, as electric light in due course is certain to find a home, not only in the mansion of the rich, but also in the cottage of the poor.—Yours, etc., ARTHUR SHIPPEY.

(For other Correspondence see page 547.)

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INCANDESCENT LAMP BULBS.

The blackening of incandescent lamp bulbs, and the consequent deterioration of the quantity of light, is one of the most practical questions with which electric light engineers have to contend. It is an all-important problem to the supply companies, for after the glamour of the novelty of the new lighting has worn off, users will ask to receive that which was promised them. We think it unfortunate that the unit lamp is taken as an equivalent to eight candle-power, because the sixteen candle-power lamp is the one by which comparisons by the public will be made. It is the lamp mostly to be found in the dining-room, the drawing-room, and the library that appeals to the user, not that used in bedrooms and passages. At the present moment none of us have a very distinct idea of what the unit life efficient lamp is to be. Are we in the near future to expect a sixteen candle-power lamp for a couple of shillings lasting a thousand hours, or, say, half that time—five hundred hours? We put it to all branches of the trade, manufacturers and suppliers, whether normal candle-power through five hundred hours is not enough to aim at. Probably that result, too, will be fairly achieved, though we doubt about getting the thousand hours. The user is told that such and such a lamp is a sixteen candle-power lamp, but directly he begins to use it the lamp begins to deteriorate, and in a short time, even if it commences with sixteen candle-power, it gives him less light. So, too, if the pressure is not kept constant at the point at which it is intended the lamp should be supplied. The supply being at too low a pressure was discussed in various papers not so very long ago, so that nothing more need be said on that part of the subject. The blackening of the bulb and its influence on the light has not, however, been examined in England to the extent it has in America. The most recent utterance on the subject is from Prof. Nichols, who, in the *American Journal of Science*, gives the results of the investigations of Messrs. Moore and Ling, in the laboratory at Cornell University. The results of these experiments were given in a note in our last issue, but the question is so important that we again call attention to it. In an investigation by Prof. Thomas and Messrs. Martin and Hassler, described in a paper before the American Institute of Electrical Engineers, the authors stated that if the life be limited to the time when the lamps give 75 per cent. of their initial candle-power, the average death is at 450 hours; while 80 per cent. as limit cuts them off at 340 hours, and 90 per cent. at 180 hours. These investigators also found that the lamps which were least blackened were those exhausted by mechanical pumps, hence it is inferred that exhaustion by mercury has a deleterious effect. The investigations of Messrs. Moore and Ling goes further than that of Prof. Thomas and his colleagues, and examines into causes. Thus it was found that the absorbing power of the coating is in itself sufficient to account for a very considerable falling off in the candle-power. The effect of the "age-coating," as they term the black deposit on

is to dim the lamp without appreciably he quality of the light. This means that anges and quality remains, so that if a r of candles is estimated for the lighting amount of light decreases 10 per cent. ed and eighty hours' use of the lamps. continues, and a quarter of the light idred and fifty hours. A brilliantly m in the first instance becomes nd indistinct visions; with gas ccurs—the light of the burner of the burner to-morrow here is our remedy? Not mechanical engineer (Mr. ...ne fame) showed us a plan ...n he thought the "age-coating" ...ared from the bulb easily and expedi-... We do not know if his experiments succeeded, but the idea was certainly worth a trial. There is another view of the matter, which, so far as we know, has not been considered by manufacturers; but as the controlling patents lapse and competition increases, the various problems attaching to incandescent lamps will be more closely examined. Prof. Nichols tells us that "the rate of deposit of the coating in incandescent lamp bulbs is greatest in the early part of the life of the lamp." Now, our view is that improved manufacture could alter this, or the manufacturer should not send the filament out in a bulb till the early life is passed. In other words, the particles from the filament should be disintegrated before, not after the use in a bulb. We ought even then to get a life of five hundred hours, and a rate of blackening and a diminution of light much slower than at present. Is this impossible? Mr. Shippey, in his letter in another column, says the cleaning is simple to those "in the know," but he does not explain the method, which we venture to state is not one that ought to be kept secret, but, for the benefit of all who use lamps, should be promulgated broadcast over the world.

A PACIFIC CABLE.

The *Times* of November 8 contains an evidently inspired article on the proposed Pacific cable, a proposal due to French initiation. We have our own views about a Pacific cable, which are not in accord with those of the *Times* article. In our opinion the directors of the Eastern and Eastern Extension Companies have for years done all they could to stop this cable, and have hitherto succeeded. Those two companies are to all intents and purposes one company, but it pays the wire-pullers to take separate salaries. They also would prefer a duplication of lines to Australia, not *viâ* the Pacific, but *viâ* the Indian Ocean. Unfortunately, the Australasian authorities have been divided, otherwise a cable through the Pacific would long since have been laid. By playing off one authority against the other, Messrs. Pender, Anderson, and Co. have got their will—are charging a far higher tariff than is necessary, and preventing the alternative route. Had the Australasian authorities agreed together, these gentlemen would long since have found it advisable to lay the Pacific cable under their own auspices. It needs little or no premonition to understand that all their plans are prepared for this purpose; and should the French proposals really come to anything there would be some more pretty cable fighting. Messrs. Pender and Anderson would turn faster than a weathercock, and a cable would be announced forthwith. Indeed, it would not be surprising to learn that the promulgation of these French proposals is due to the direct or indirect action of these companies. The important consideration for Englishmen is in the last sentence of the *Times* article—in fact, in the last phrase: "That the line must pass through some countries where the British Government was not supreme." Now we hold that this line should pass through countries where the British Government is supreme. Will it be believed that we have absolutely no line which our Government can control? We cannot send a message to our Asiatic colonies without the permission of a foreign Government, nor without the permission of Governments which are always more or less hostile to us. We cannot reckon upon the Governments of France, Spain, or Portugal, or upon those through whose territories the Indo-European lines pass, for neutrality or for friendship in our extremity. What we want, and what we ought to have when another international upset arises, is a means of communication wholly through English territory and under English control. This can be obtained by connecting Canada West with New Zealand or Australia, and this Pacific line should be a Government line, and under the control of no company. It should be worked at the cheapest possible rate, and if properly managed, as the Post Office Telegraph Department can manage when it has a mind to, the traffic receipts would pay a fair percentage upon the outlay. The aim of the companies all along has been to play off colony against colony, and nation against nation, to serve their own ends. There has been no patriotism, except when patriotism was intended to pay. If the shareholders reaped the full benefit of such policy, it would be a different matter; but they do not. Surely the colonies in Australasia have shown themselves patriotic enough when the welfare of the mother country was in question, and they, together with Canada and the mother country, could establish a chain of telegraphic communication under the absolute control of Britain and Greater Britain.

QUICK WORK AT HOVE.

Electrical central supply contractors are obtaining well-deserved fame in some instances for the extremely rapid work in erecting machinery and starting the supply. A recent instance of this is the central station at Hove. The New Hove Electric Lighting Company acquired, some short time back, the statutory powers under the Board of Trade provisional order granted to the Hove Commissioners in 1890, and on Saturday last supply of current was commenced to residents in about two miles of streets from a temporary central lighting station in Holland-road.

The contract for this work was placed with Messrs. Crompton and Co., Limited, exactly ninety days before the date of first supply, and the two miles of mains were laid in sixty days, an extremely smart piece of work. A large number of private consumers' houses are already wired for the electric current, and others are being wired. About one thousand three hundred lamps are connected up, thus ensuring an income of some £700 to £800 per annum from the commencement. The Hove Commissioners propose to light the Town Hall and municipal buildings with some six hundred lights, and they also intend to erect a large number of arc lamps in the streets. Messrs. Crompton and Co., Limited, are under contract for completing the laying of mains in the compulsory area by the 19th March, and they have also to erect the permanent generating and distributing station. The active manner in which both installation and distribution is being carried out promises exceedingly well for the new company, and the example will serve to have an inspiring effect on corporations still lagging in hesitation.

THE FATAL ACCIDENT AT KENSINGTON.

We should have made some remarks about this sad, and unfortunately fatal, accident at the House-to-House Company's Kensington installation last week, but pressure on our space prevented us. The facts are simple: the man T. P. Lang was handling a live wire in the ordinary course of business. The installation was probably defective, and he received a current under 2,000 volts pressure, which was instantaneously fatal. In this country the number of fatal accidents through electric light operations have, fortunately, been few, a fact which speaks well of our general workmanship. Familiarity with electrical machinery is apt to cause carelessness, and in this particular case no doubt had the indiarubber gloves been used, which at the inquest were said to be provided and ordered to be used by the company, there would have been no fatal accident. The management may make rules and provide proper appliances, but it is another matter to compel workmen to comply with such rules. In all branches of work the same difficulty arises. We have been in rooms where emery-wheels were going on every side, where the air was laden with dusty, death-dealing particles, where provision was made that every workman should wear what we might term a dust-sieve to prevent inhalation of the dust, but half the workmen are always found with no protection. Possibly it is the same in electric light matters, and the only remedy is to be exceptionally severe where negligence or breaking of rules is reported. Too great care cannot be exercised in all that concerns electric light operations, because its enemies will propagate in the widest manner tales of any indication that it is unsafe. We contend—we have always contended—that it is the safest artificial illuminant known, far and away superior in this respect, as in others, to both gas and oil.

INSTITUTION OF ELECTRICAL ENGINEERS, Nov. 24

EXPERIMENTAL RESEARCHES ON ALTERNATE-CURRENT TRANSFORMERS.

BY J. A. FLEMING, D.SC., F.R.S., MEMBER

Prof. Fleming's paper is an extremely lengthy and elaborate one, with a large number of illustrations. A considerable portion of the paper, however, is only of value to those whose hobby is "historic continuity." This enables us the better to give abstracts from the paper instead of the whole, which latter we should prefer. To make our course plain, the user of transformers, for instance, wants information about those made now, and cares little about the results obtained from those made a few years ago. The same may be said of those who use instruments: the value they want is that of the latest, not the oldest. On the other hand, the historian and the antiquarian want to know the continuous history of the machines or apparatus from the earliest to the very latest types. Prof. Fleming in this paper admirably caters for both classes but we must restrict most of our abstracts to information relating to latest types.

After introductory paragraphs, the author describes

THE METHODS OF MEASUREMENT EMPLOYED.

Mr. Swinburne placed at my disposal four of his electrostatic torsional voltmeters, and also two of his dynamometer wattmeters, and there was also at hand a sufficient supply of Kelvin [illegible] balances and electrostatic voltmeters and other appliances for the calibration of the above instruments. Since these Swinburne electrostatic voltmeters proved useful in much of the work, it may be advantageous to point out their good and bad points, and also to say how they were improved, calibrated, and used in the experiments. As they have been sufficiently described by their inventor, suffice it to say that they consist of two pairs of semi-cylindrical metal boxes B (Fig. 1), insulated from each

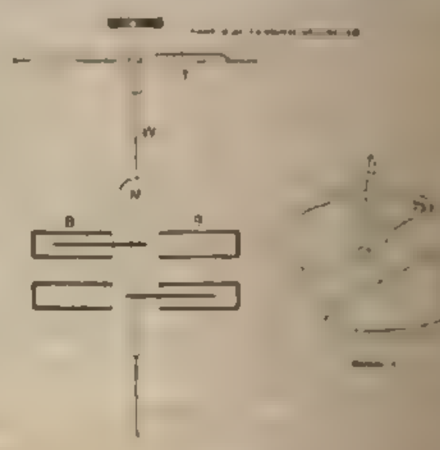


FIG. 1.

other. A vertical metallic axis carries two semicircular aluminium "needles," set at different levels, so that one is [illegible] the upper pair of boxes and the other in the lower. The [illegible] is strung at the top and bottom by a round phosphor-bronze wire 0·003in. or 0·004in. diameter, and the top end of the upper wire is held by a torsion head, T, the indicating needle of which moves over a graduated scale. In most of the experiments [illegible] voltmeters were used as idiostatic voltmeters, and the [illegible] and one pair of semi-cylinders formed one terminal of the instrument, and the other pair of semi-cylindrical boxes [illegible] terminal. When a definite potential difference is made between the two terminals, the needle is displaced from its [illegible] position, and the semicircular needles attracted into the [illegible] cylindrical enclosing boxes, which are at a different [illegible]. The upper torsion head is then turned until the needle is [illegible] back to its initial position. This is accurately [illegible] affixing a mirror to the axis of the electrometer needle. The image of the filament of an incandescent lamp is then thrown [illegible] the mirror by a lens, and, after reflection, received on a paper [illegible] about one metre away. By a simple reference point on [illegible] it is easy to bring back the line of light accurately to [illegible] position. In first working with these instruments we were [illegible] troubled by electrical discharges passing across from the [illegible] to the cylinders and destroying the suspending wire by the [illegible] ing current. The simple remedy for this was found in [illegible] each semicircular aluminium line of the "needle" [illegible] thin sheets of mica which projected slightly over the edge of the sheet of metal. The instrumental utility of the voltmeter was [illegible] at all impaired, whilst at the same time discharges between the needle and enclosing boxes were prevented, and much [illegible] thereby saved. The sensitiveness of the voltmeter was such [illegible] when used to read an alternating potential of 2,000 [illegible] a change of three or four volts was easily detected, and with [illegible] steady potential there was no difficulty in taking the readings to about this number of volts to one-quarter per cent. accuracy.

In calibrating these voltmeters, the first step was to prepare a

standard inductionless resistance capable of carrying, without sensible heating, a current of at least a quarter of an ampere, and which could be subjected to an alternating pressure of 2,000 to 3,000 volts without risk of short circuiting. This was formed by winding double silk covered platinoid wire No. 36 B.W.G. round a wooden frame. The wire windings were each kept separate by being wound in serrations, or teeth, cut in the edge of varnished slate slips fixed at the top and bottom of the frame. The frames were about 37in. long, and 14in. wide, and the wire made 56 turns round the frame, each turn of wire being separated by about a ¼in. from its neighbours. The length of wire on each frame was about 126 yards, measuring some 1,600 ohms. Six of these frames were provided, giving us, therefore, about 9,600 ohms resistance in the form of a wire perfectly insulated in every part and between every turn. This wire was capable of carrying about one quarter of an ampere without any very sensible heating, and about three quarters of an ampere without exceeding safe limits. Every part of the wire was accessible, and exposed to the cooling action of the air. The six frames were fastened up to the ceiling of the laboratory and arranged so that the direction of the wire windings was alternately right and left. The resistance of all these coils was measured when at 15deg. C., and found to be as follows:

Coil.	Ohms.
1	1,607·2
2	1,595·5
3	1,525·5
4	1,649·0
5	1,640·1
6	1,645·7
Total	9,543·0

On coil 1 two terminals were placed, one at a distance of 394·7 ohms from the end, and one at a distance of 1,212·5 ohms from the end. By taking leading wires from these points it was possible to divide the whole resistance of 9,543 ohms into two sections, having in one case resistances in the ratio of 23·175 to 1, and in the other case a ratio of 6·87 to 1. This divided resistance was a practically non-inductive resistance of about 10,000 ohms, divisible into two sections in the ratio of 23 to 1 or 7 to 1. If a measured alternating pressure of 2,400 volts was applied to the ends of this resistance, the wire came to a steady temperature of about 20deg. C. to 25deg. C. above the atmospheric temperature (15deg. C.), as nearly as could be judged by a thermometer. Taking the coefficient of change of resistance with temperature for platinoid as equal to 0·021 per cent. per degree, it will be found that at 40deg. C. the whole coil would have a resistance of 9,591 ohms, and hence, if truly non-inductive, the current through the coil would then have a value of $\frac{2400}{9591}$ ampere, = 0·250 ampere. The actual current, carefully measured by a Kelvin deciampere balance, was found to be exactly 0·250 ampere, thus showing that the resistance was, for all practical purposes, non-inductive.

In all subsequent experiments it was therefore taken that when an alternating pressure of 2,400 volts was applied to this resistance, it passed a current of 0·25 ampere and absorbed 600 watts. This resistance will be hereafter called the "No. 1" resistance for reference. By the aid of this divided resistance the Swinburne voltmeters were easily calibrated.

A 24 to 1 transformer, T_1, was connected to 100-volt mains through a rheostat so as to raise the pressure and enable it to be regulated within limits. The above standard divided resistance was placed across the high tension terminals, and a Kelvin multicellular electrostatic voltmeter and a Swinburne electrostatic voltmeter, connected respectively to the small section and to the whole length of the resistance.

By taking the readings of the Kelvin electrostatic voltmeter corresponding to various pressures and multiplying these readings by 24·175 we obtained values for the P.D. *effective* potential difference at the terminals of the Swinburne voltmeter, and hence the true values of the instrumental readings of the last named instrument. For each Swinburne voltmeter a calibration curve was then prepared, in which the *horizontal* abscissæ were the torsion head readings, and the corresponding ordinates the true P.D. in volts at the terminal of the instrument. This curve was found to be a very exact parabola.

In addition to the above standard resistance, another set of six similar coils was provided, each coil of which consisted of No. 32 B.W.G. platinoid wire wound in the same open manner on a frame. Each of these coils had a resistance of about 500 ohms, and each coil could carry comfortably, without any very sensible heating, about half an ampere. These last six coils were specially intended to be used for current measurement, as follows. The coils were arranged either two, four, or all six in parallel, and the current to be measured passed through them. The P.D. at the ends of the compound resistance was measured by a Kelvin electrostatic voltmeter. The arrangement was standardised as an ampere meter by passing known currents through the coils, measured by a Kelvin ampere balance, and then observing the P.D. at the ends of the compound resistance. In this way the true resistance of the coils grouped in various ways when carrying currents was found, and at any subsequent time the mere reading of the P.D. at the ends of the resistance gave the current passing through the coils. The reason for employing an electrostatic voltmeter and resistance in this way to measure current was that we thereby obtained an inspectional ampere meter much more convenient in many experiments than an ampere balance or dynamometer. It will be seen, therefore, that all the measurements were ultimately referred to one Kelvin electrostatic voltmeter and one Kelvin deciampere balance. These instruments were found to agree with one another. Any other instruments, such as Siemens's dynamometers or an Ayrton and Perry twisted-strip ammeter, sometimes used, were standardised and referred to the above mentioned Kelvin balance, which was one specially constructed for alternating current measurement.

This last mentioned set of six resistance coils will be hereafter spoken of as the "No. 2" set. We frequently employed the No. 1 and No. 2 resistances in series, giving us a practically non-inductive resistance of about 12,000 ohms. The No. 1 resistance was also employed as an absorber of power. For if the six coils, each of about 1,600 ohms, were arranged three in parallel and two in series, we obtained an effective resistance of about 1,100 ohms, and this, when placed across a 2,400-volt circuit, passed a total current of rather more than two amperes and absorbed about 5,000 watts. We found it very convenient to employ this resistance in this manner as a standard non-inductive power absorber for obtaining the constant of various forms of wattmeter. Although using the No. 1 resistance in this way to absorb nearly 7 h.p., the current passing in each single wire was not more than two thirds of an ampere, or well within the safe limits.

Experiments with the Three Voltmeter Method of Measuring Alternating Current Power.

Having the necessary instruments all calibrated and compared, a series of experiments was made with three or four of the Swinburne voltmeters, using them in accordance with the well known method, for measuring the power taken up in transformers on open secondary circuit.

Two 5 h.p. transformers were arranged with low-tension coils in parallel on a 100-volt circuit, and high-tension coils (2,400 volts) in series, Fig. 2. The current through the low pressure coils could be varied by a rheostat, *r*, and hence the P.D. at the high-tension terminals of the transformers given any desired value from 2,400 volts downwards.

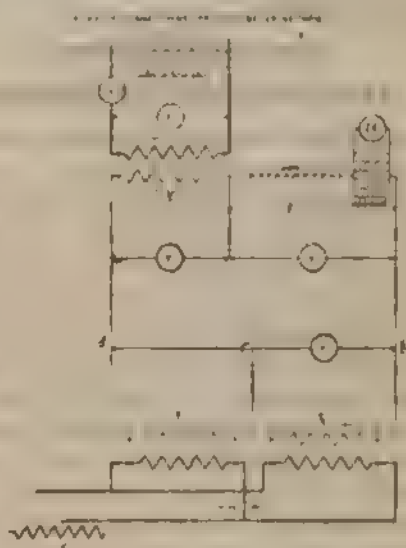


Fig. 2.

In the diagram, T is a transformer in which the power taken up is to be measured; T_1 and T_2 are the 5 h.p. pressure transformers just mentioned. The torsion voltmeters, V_1, V_2, V_3, were arranged as shown, V_1 being across the terminals of the transformer to be measured, V_2 being across a non-inductive resistance, r_1, put in series with the primary coil of the transformer T, and V_3 used to measure the total P.D. between the outside terminals of the two pressure producing transformers, T_1 and T_2. Since T_1 and T_2 were identical transformers, it was generally quite sufficient to measure the P.D. between the terminals of one transformer, T_1 or T_2, and to take double this P.D. as the value of V_3, except in cases where the total P.D. exceeded the limits of safety for one voltmeter, and then two voltmeters were used, one across the terminals of each transformer. Under these circumstances, as is well known, the power, W, taken up in the transformer, T, under test is given by the formula,

$$W = \frac{1}{2r_1}\left\{ V_3^2 - V_2^2 - V_1^2 \right\}.$$

In applying this method we had several difficulties to overcome before we could get any satisfactory results. In the first place, the transformer to be tested must have the potential difference V_1 between its primary terminals always exactly maintained at the normal pressure, which in all our experiments was 2,400 volts. In the second place, the potential difference V_2 must always be made as nearly equal to V_1 as possible, in order to obtain the condition of greatest probable accuracy of measurement; that is, to obtain the condition in which given small percentages of error in the several voltmeter readings produce the minimum percentage error in the calculated power. In the third place, the resistance r_1 must be practically non-inductive, and must be capable of being varied in amount as required to fulfil the condition of making V_2 equal to V_1. We met these conditions in the following manner: In cases in which

the transformer T was not loaded on the secondary circuit, and in which, therefore, the current flowing through its primary circuit was not greater than could be comfortably carried by the No. 1 10,000 ohm standard resistance, we employed that resistance, arranging all six coils in series. In series with this we placed some or all of the coils of the second resistance, arranged in series or in parallel, and we placed a Kelvin voltmeter to read the fall in volts down one of these last coils. In other cases, when the transformer T was loaded up on its secondary circuit, and when, therefore, a larger current was flowing through its primary circuit, we employed a series of 24 50 c.p. 100 volt incandescent lamps, or several series of lamps in parallel, adjusted as required to obtain the requisite resistance. When these lamp resistances were used, the second No. 2 set of resistance coils, arranged with two, four, or six in parallel, as necessary, were placed in series with the lamps. By measuring the fall in volts down this known wire resistance by a Kelvin electrostatic voltmeter, *Th*, and the fall in volts over the lamps and resistance taken together by means of one of the Swinburne voltmeters, V_2, we were able to determine at any instant the value in ohms of this non-inductive resistance from the readings of two electrostatic voltmeters and the known value of the wire resistance across the terminals of the Kelvin voltmeter.

The process of getting a reading was thus. The resistance r_1 was varied suitably until the value of the P.D. V_2 was as nearly as possible equal to the value of the P.D. V_3. The feeding transformers, T_1 and T_2, had a rheostat in their common low pressure circuit, which was then varied until the P.D. V_1 came to the value 2,400 volts, and it was constantly maintained at that value. The reading of the other two voltmeters was then noted, as well as that of the Kelvin voltmeter Th. If we call A the ampere value of the current flowing through the primary coil of the transformer T, and therefore also that through the resistance r, it is obvious that the value of r is determined at once from the value of the P.D. V_2 and the value of the current A. A is, of course, known by the previous calibration of the Kelvin voltmeter and associated resistance as a non-inductive ampere-meter. Hence, if V_1 is constantly maintained at the value 2,400 volts, we see that the power, W, taken up in the transformer is given by the formula,

$$W = \frac{A}{2\,V_2}\left\{ V_3{}^2 - (2{,}400)^2 - V_2{}^2 \right\}.$$

If it had been possible to make V_2 also always exactly 2,400 volts, the formula would have been still more simplified.

It will be observed that we used a row or rows of 24, or less, 50 c.p. incandescent lamps as our non-inductive resistance, and determined the actual resistance at any instant by observing the terminal P.D. of the row of lamps and the current flowing through them as measured by the fall in volts down a small known non-inductive resistance placed in series with them. We found this to be a better method than using any form of ammeter in series with the lamps: firstly, because we were more sure of not introducing perceptible inductance into the lamp circuit; and secondly, because we found we could obtain greater accuracy in the measurement of the current than by any other ammeter suitable for the purpose. The justification for using such a row of lamps as a practically non-inductive resistance is that if an incandescent lamp is placed in series with a dynamometer suitable for measuring both alternating and continuous currents, and if the terminal P.D. on the lamp is adjusted, say, to 100 volts as measured by an electrostatic voltmeter, no sensible difference can be found in the current as measured by the dynamometer, whether that current is alternating or continuous.

It will be seen that when the transformer under test is loaded on its secondary circuit, in addition to the ammeter and voltmeter measurements necessary to estimate the secondary load, we have four, and sometimes five, other voltmeter measurements to make simultaneously in order to get one observation of the power absorbed in the transformer. In dealing with the mere theory of an experimental method, nothing is easier than to say, "Let V be a constant P.D.," but in actual practice, and when working off the mains of existing public electric supply companies, this ideal condition is very difficult to realise, and the observers have their patience strained often almost up to the safe working limits to obtain any results worth having at all. We found that the multiplicity of readings to take simultaneously constituted a very great drawback to the utility of this voltmeter method. Having the apparatus, however, set up, and the instruments all calibrated, the method was applied to measure the power absorbed in a number of transformers with open secondary circuits, and in one or two cases the power taken up in the transformer corresponding to various secondary loads was also taken.

The results of some of these observations are given in the fourth column of Table I., in which the determinations of the power absorption of various transformers at no load obtained by different methods are collected. In this table the first column gives the maximum output in watts of the transformer; the second gives the "magnetising current," or primary current, at no load; the third the primary volts, or P.D. at the primary terminals; the fourth, fifth, sixth and seventh columns give various power determinations; the eighth gives the "apparent watts" absorbed at no load, or the numerical product of magnetising current and primary volts; and the ninth column gives a number which it is convenient to call the power factor of the transformer at no load—it is the ratio of the true to the apparent watts. If the currents and pressures were simple sine functions, then the power factor in that case would be the cosine of the angle of lag of primary current behind the primary terminal potential difference.

TABLE I.—Power absorbed by various Transformers with Open Secondary Circuits at a Frequency of 83 complete periods.

	1	2	3	4	5	6	7	8	9
Transformer.	Maximum output in watts from secondary.	Magnetising current in amperes.	Primary volts.	Power in watts absorbed at no load: By voltmeter method.	By ammeter method.	By dynamometer wattmeter, W.	By Swinburne wattmeter.	Apparent power, W.	Power factor, W/W.
Ferranti—									
1885 pattern	1,875	18	2,416	288	—	—	—	421	[illegible]
(1885 pattern)	3,750	337	2,400	640	580	549	511	[illegible]	[illegible]
(1885 pattern)	7,500	25	2,435	444	—	—	—	[illegible]	[illegible]
(1885 pattern)	11,250	34	2,447	578	—	—	—	[illegible]	[illegible]
(1886 pattern)	15,000	57	2,389	1,019	—	—	—	[illegible]	[illegible]
(1885 pattern re wound)	3,750	·11	2,400	—	—	233	220	[illegible]	[illegible]
1892 pattern)	7,500	·075	2,400	—	—	138	—	[illegible]	[illegible]
(1892 pattern)	11,250	·076	2,400	—	—	148	116	[illegible]	[illegible]
(1892 pattern)	15,000	112	2,400	—	—	228	193	[illegible]	[illegible]
(1892 pattern re wound)	11,250	103	2,400	—	—	228	—	247	[illegible]
Swinburne, "Hedgehog"	3,000	74	2,400	112	111	112	74	1,776	[illegible]
Westinghouse	6,500	05	2,400	93·5	97	95	95	[illegible]	[illegible]
Mordey Brush	6,000	·078	2,400	126*	—	140	106	[illegible]	[illegible]
"	750	0317	2,392	61·5	—	—	—	76	·81
Thomson Houston	4,500	043	2,400	—	—	105	83	100	[illegible]
Kapp	4,000	145	2,400	—	—	152	113	348	·41

* The power determination by the three voltmeter method—viz., 126 watts—was made on one transformer, No. 1,952. The power determination by the dynamometer—viz., 140 watts—is the mean of four values obtained on another transformer, No. 1,868, the [illegible] value of which is also 126 watts.

In criticising these results, it must be borne in mind that some of the transformers were intended to be used at a frequency of 100, and not at 83, and that, therefore, comparisons between the resulting numbers are not to be instituted without regard to this circumstance. Moreover, on different days the frequency varied from 83 to 88, and this appreciably affects the power absorptions. As an example of a series of voltmeter tests, we give in Table II. the details of the observations on a series of [illegible] at no secondary load. In these tables V_1 is the voltmeter reading of the P.D. of the primary terminals of the transformer under test; V_2 is the P.D. between the ends of the non-inductive resistance, R; V_3 is the P.D. between the terminals of the pressure-supplying transformers, and W is the power in watts being taken up in the tested transformer, calculated by the formula from the three voltmeter readings. The frequency employed in each case is stated, and the value of R, the non-inductive resistance, is also given in each case. The column headed "By Swinburne Wattmeter" records the power readings taken with the first wattmeter in a brass case sent with the [illegible]-watt "Hedgehog" transformer. Quite lately another wattmeter with an ebonite outer case, was sent. This will be afterwards referred to as the "second wattmeter."

TABLE II.—Tests of Power absorbed on Open Secondary Circuit by various transformers, taken by the Three Voltmeter Method.

(1) Westinghouse transformer, 6,500 watt. R = 9,678 ohms, frequency 86·7 complete periods, magnetising current [illegible] amperes, power factor, 0·79, apparent watts taken up at no load 118. Mean of five readings = 93·5 watts.

(2) Mordey transformer, 6,000 watt. R = 12,630, frequency 82·7 complete periods, magnetising current 0·0724 ampere, power factor 0·72, apparent watts taken up at no load [illegible]. Mean of seven readings = 126 watts.

The application of the three voltmeter method to closed magnetic circuit transformers, or transformers with large power factor at no load, showed that it was possible with care to obtain very fairly good power determinations agreeing well with one another, although the number of instruments to be read rendered it exceedingly difficult, unless the pressure was absolutely steady, to get the benefit of the full possible individual accuracy of each instrument. The moment, however, that we turned attention to transformers with small power factor, such for instance as the Swinburne "Hedgehog," the difficulty of obtaining very accurate results was considerably increased. The reason for this is explained in a paper by Prof. Ayrton and Dr. Sumpner on the "Measurement of the Power given by any Electric Current to any Circuit."

Assuming currents and potentials to vary harmonically, we show that if the same percentage error, e, is made in reading each voltmeter, the percentage error in the calculated power will be

$$\sqrt{\frac{2 + 4(1 + \cos\phi)}{\cos^2\phi}}$$

times c, where $\cos\phi$ may be approximately taken to be the same quantity as that which we have above called the "power factor." Hence if $c = 1$, and $\cos\phi = 0·75$, the multiplier is found to be 5; but if $c = 1$ and $\cos\phi = 0·06$, then the multiplier is 40. In other words, a uniform error of 1 per cent. in the voltmeter reading makes only 5 per cent. error in the power when operating on a closed-circuit transformer, but a 1 per cent. voltmeter error means a 40 per cent. error in the power when testing a "Hedgehog." Hence, unless the very greatest constancy in the alternating pressure can be obtained, the three voltmeter method will not give good results when applied to an open magnetic circuit transformer. In order to show the extent of variation of the power determinations from the mean value, when applying the three voltmeter method to a "Hedgehog" transformer on open secondary circuit, the individual values obtained on different occasions were grouped showing the mean value of the power absorbed by the open circuit "Hedgehog" in these experiments to be respectively 155, 101, and 85 watts at no load. The mean of the means is 114 watts. Besides the above experiments, a number of other quite similar ones were made with the same method, which gave results as follows—viz., 111, 100, 132, 97, 118, 118, 119, 114, 98, 95, 103, and 88 watts. The mean of all the 30 determinations made with the three voltmeter method is 112 watts. This is, therefore, the mean result for the power in watts absorbed by the 3,000 watt "Hedgehog" transformer on open secondary circuit when worked at a frequency between 83 and 88. The greatest value of the watts is 171 and the least 64, and the greatest deviation from the mean is 59 watts, or, roughly, 50 per cent. The transformer was marked by the maker to be worked at 100 periods per second. We used it at 83 to 88. It appears, therefore, that, owing to the low power factor of this transformer, it is a bad subject for the three voltmeter method, and that even with the greatest precautions considerable deviations from the mean may occur in making a series of power measurements in its case. Nevertheless, it will be shown later on that there is reason to believe that the mean value so obtained of the power absorbed at no load—viz., 112 watts—is not far wrong.

As regards the three voltmeter method itself, considered as a practical method of measuring alternating current power, the following conclusions were impressed upon us: 1. It is only applicable in cases when a very steady alternating pressure can be obtained of the requisite amount, and it is therefore unsuitable in general for working as a workshop method, or off commercial alternating circuits. 2. Owing to the number of instruments to read, it is difficult to carry it out as a practically useful method without the assistance of several observers. 3. It is especially difficult, if not impossible, to get good results with it when applying it to test transformers of open magnetic circuit type, and having therefore a small power factor. 4. Unless all the conditions for maximum accuracy can be secured, owing to the nature of the formula for the calculation of the power, the results will not be very trustworthy.

In applying the method to measure the power taken up in the primary circuit of a transformer when the secondary circuit is loaded up, the non-inductive resistance R, must be capable of passing the full primary current required, and yet be capable of being so adjusted that at each stage of the load the fall of volts, V_2, down this resistance is approximately equal to the pressure, V_1, on the terminals of the primary of the transformer being tested. It is essential that this last condition shall hold good, or else we do not obtain the same probability of accuracy in the calculated value of the power given to the primary circuit at all loads. It was found, therefore, that the most convenient arrangement to employ for the non-inductive resistance was one or more parallel series of incandescent lamps. We employed one series of 24 50-c.p. 100 volt lamps and two series of 24 16 c.p. 100 volt lamps, the three series being arranged in parallel when required, and any required number out of the 24 lamps in each series taken. In order to measure the resistance at any instant of this bank of lamps, the second set of six non-inductive resistance coils was arranged in series with the lamps, and the drop in volts down this known resistance measured with the Kelvin electrostatic voltmeter. This gave us the current flowing through the lamps and the Swinburne voltmeter gave us the P.D. over lamps and resistance. Hence, knowing the terminal P.D. and the current, we have the value of the non-inductive resistance r_1 at any instant given by the inspection of two voltmeters. In making the full tests at all loads of a transformer by this method, the power given out from the transformer was taken up on a bank of incandescent lamps, and the current and terminal volts measured by a Kelvin balance and Kelvin multicellular electrostatic voltmeter. The results of a double series of observations on a Ferranti 5-h.p. 1885 (old form) transformer, and those on a Swinburne 3,000 watt "Hedgehog" are tabulated.

In these tables the first three columns give the volts, current and watts output, W_2, of the secondary circuit; the fourth column gives the primary current; the fifth the value of the inductionless resistance in series with the primary; the sixth, seventh, and eighth columns give the values of the voltmeter readings, V_1, V_2 and V_3; the column headed W_1 is the calculated value of the power given to the primary circuit; the last two columns give the value of $W_1 - W_2$, or the total power in watts absorbed in the transformer, and the ratio $\frac{W_2}{W_1}$, or the efficiency, expressed as a percentage. The values of $W_1 - W_2$ are the total power in watts dissipated in the transformer, partly as copper frictional losses (C^2R losses), partly as iron losses (eddy current and hysteresis), and in any other way, such as eddy currents in the copper circuits by which internal work is being expended.

[Tables V. and VI. relate to the old form of Ferranti transformer. Tables VII. and VIII. relate to the Swinburne Hedgehog. We give Table VII.—ED. *E.E.*]

TABLE VII.—Swinburne "Hedgehog" Transformer.

No. 342. Power = 3,000 watts. Secondary volts = 100. Frequency used 83·7 periods per second. Average final temperature of transformer, 147deg. F. Volts on primary circuit (V_1) = 2,400 (kept constant). Primary circuit resistance = 24·00 ohms at 145deg. F. Secondary circuit resistance = 0·051 ohm at 145deg. F.

Secondary circuit.			Primary circuit.							
Volts.	Amperes.	Watts = W_2.	Amperes.	Resistance = r_1.	Observed volts V_1.	V_2.	V_3.	Watts = W_1.	Total power taken up in transformer = $W_1 - W_2$.	Efficiency = $\frac{W_2}{W_1}$ in per cents.
102·0	0	0	0·738	3,101	2,400	2,289	3,424	118	118	0
102·0	0	0	0·73[illegible]	3,105	,,	2,[illegible]	3,429	118	118	0
102·0	0	0	0·73[illegible]	3,105	,,	2,2[illegible]	3,430	119	119	0
102·0	0	[illegible]	0·738	3,1[illegible]6	,,	2,29[illegible]	3,430	118	[illegible]	0
101·9	1·06	108	0·75[illegible]	3,059	,,	2,3[illegible]4	3,542	232	121	46·6
101·9	2·12	216	0·763	3,063	,,	2,342	3,667	316	100	68·4
101·9	2·71	276	0·761	3,070	,,	2,391	3,735	422	[illegible]	65·5
101·8	4·20	427	0·775	3,057	,,	2,3[illegible]0	3,908	510	83	83·8
101·5	9·34	952	[illegible]	3,[illegible]	,,	2,627	4,338	1,033	81	92·0
101·0	12·65	1,278	0·969	2,[illegible]38	,,	2,847	4,691	1,391	113	91·8
100·5	15·62	1,570	1·0[illegible]	2,585	,,	2,719	4,658	1,657	[illegible]	94·8
100·2	19·00	1,904	1·161	2,220	,,	2,570	4,612	1,997	[illegible]	95·5
100·[illegible]	21·6[illegible]	[illegible]168	1·25[illegible]	1,803	,,	2,333	4,433	2,258	90	96·0
99·0	30·10	2,980	1·5[illegible]	1,470	,,	2,33[illegible]	4,530	3,1[illegible]9	209	93·5
102·0	0	0	0·756	3,073	,,	2,323	3,444	114	114	0

Curves representing the values of $W_1 - W_2$ for the Ferranti 5 h.p. transformer, taken from the results obtained, were shown. The secondary output of the transformer in watts is set off on the horizontal line, and the vertical ordinates of the upper curve are the corresponding values of the "total lost watts," or total power losses in the transformer at these various loads. The lower curve is the curve of total copper (C^2R) losses, taking both primary and secondary together. The difference between the ordinates of the upper and lower curves represents the power lost in the transformer in iron losses and eddy current copper losses, if any. It is seen that the upper curve keeps roughly parallel to the lower curve, and that therefore, as far as these observations go, there is no indication that the core losses get less as the output increases; on the other hand, they seem to get slightly greater. It is much more convenient and instructive to plot out in this way a "total loss curve" for the transformer than to plot an efficiency curve, for if an accompanying C^2R curve is drawn, it shows us at once what is the magnitude of the total eddy current and hysteresis losses to be accounted for. The values of $W_1 - W_2$ for the Swinburne "Hedgehog" are found when plotted to lie so irregularly that an exact determination of the total loss curve by these tables is impossible. The power factor of the "Hedgehog," even at full load, is still small, and we were not satisfied with the general nature of the results given at all loads by the three voltmeter method for this transformer. In the case of the Ferranti 5 h.p. transformer (1885 type) the determinations of the power taken up at no secondary load were fairly consistent, being as follows for seven observations: 516, 515, 504, 540, 538, 509, 516, all taken at a primary pressure of 2,400 volts and a frequency of 82 to 85. The mean of these values is 520 watts. At a frequency of 87 and a primary voltage rather above 2,400, we found for the same quantity the values 563, 565, 568, 552, 568, 561 watts, in six different experiments. The mean of all, corresponding to a frequency of about 83, is probably close to 540 watts.

EXPERIMENTS WITH THE THREE AMMETER METHOD OF MEASURING ALTERNATING CURRENT POWER.

We next directed our attention to that modification of the voltmeter method suggested by the writer, and which involves current measurements instead of pressure. Theoretically, this method requires three ammeters, A_1, A_2, A_3, arranged in connection with the transformer under test, as shown in Fig. 3. The third ammeter, A_3, measures the current flowing through an inductionless resistance put across between a pair of high tension mains kept at the potential required for the primary circuit of the transformer to be tested. Two other ammeters, A_1 and A_2, measure the current before and behind the point of take-off of this resistance. In putting this method into practice, we found it necessary in the first place to scheme some simple method of regulating the P.D. at the terminals of the transformer under test. This was accomplished as follows. A 10-h.p. transformer had its primary, or fine wire, circuit inserted in series with the primary current of the transformer under test. The secondary, or thick wire, circuit of the 10-h.p. transformer was closed through a variable resistance consisting of 15 to 20 plates of battery carbon 3in. square and ¼in. in thickness, pressed together more or less by a screw clamp. By suitably compressing these plates we were able to regulate with great nicety the secondary current of the 10-h.p. transformer, and hence to adjust the resultant impedance of the primary circuit of the 10-h.p. transformer. The volts at

the terminals of the transformer under test could then be kept perfectly constant, irrespective of slight variations due to the dynamo. This adjustment was made by placing one of the Cardew or Swinburne voltmeters across the terminals of the transformer under test, and always adjusting the carbon rheostat until the P.D. of these terminals was 2,400 volts. As a non-inductive resistance we employed a series of 50 c.p. incandescent lamps. We then found that, working under these conditions, we could dispense with the third ammeter, A_3, and make one measurement once for all of the current taken by this series of lamps at 2,400 volts. We found that this current remained constant over great ranges of time. The experiments consisted, therefore, in measuring the primary current of the transformer under test by two ammeters in series, from the junction point of which was led off the constant current for a series of lamps. The P.D. at the ends of this series of lamps was kept perfectly constant at 2,400 volts, as shown by the voltmeter, V. We found considerable difficulty in getting two suitable ammeters for the positions A_1 and A_2 which would agree with one another with the requisite accuracy, and finally we reduced the method to the use of a single ammeter as follows. An ammeter was put in the primary circuit of the transformer under test, and the P.D. at the terminals of this transformer was kept constant at 2,400 volts. A series of incandescent lamps, generally 24 100-volt 16 c.p. lamps, was joined across the primary mains, and two readings of the ammeter taken—a first when the row of lamps was between the ammeter and transformer, and a second when the ammeter was between the lamps and transformer. An independent determination was made of the current taken by the lamps. These changes of position of the ammeter were made by mercury cup connections, so as to avoid at any time actually breaking the primary circuit. As an ammeter we employed first an Ayrton and Perry twisted strip ammeter and finally a Siemens dynamometer of low resistance. It will be easily seen that this single ammeter method possesses all the advantages, whatever they are, of the three ammeter method, and is much simpler to work.

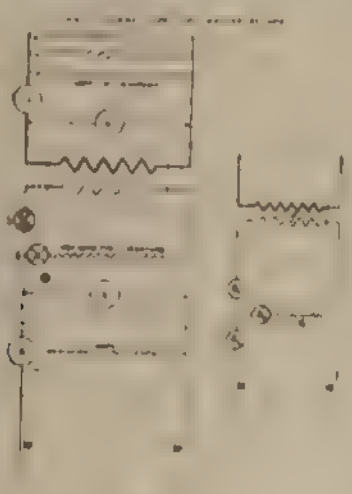


FIG. 3.

If A_1 is the reading of the ammeter when it is between the transformer and the lamps and A_2 the reading when the lamps are between it and the transformer, and A_3 is the value of the current through the lamps, and V the P.D. at the terminals of the series of lamps, it is easy to show that the power, W, taken up in the transformer is given by the expression,

$$W = \frac{V}{2 A_3} \left\{ A_2^2 - A_1^2 - A_3^2 \right\}.$$

In order to test the method, we applied it to measure the power taken up in the practically inductionless resistance coil No. 1 standard. The resistance of this coil when traversed by about a quarter of an ampere is 9,590 ohms. The value of the currents were in this case $A_2 = 0.88$, $A_1 = 0.24$, $A_3 = 0.65$, and $V = 2,400$.

Hence the power taken up, as calculated from the three ammeter observations, is 544 watts; whilst the power absorbed, as reckoned from the known value of the resistance and current going through it, is 552 watts. Applying it to measure the power absorbed in two transformers already tested by the voltmeter method, viz., the 5 h.p. Ferranti and the 6,500-watt Westinghouse—when on open secondary circuit the number obtained by the ammeter method was 590 watts for the Ferranti and 95 watts for the Westinghouse. These values are rather higher than the mean values obtained by the voltmeter method, viz., 540 and 93.5 watts; and, in spite of its greater simplicity, the one ammeter method did not give very satisfactory results, even on closed magnetic circuit transformers. It was next applied to test the Swinburne 3,000 watt "Hedgehog" when on open circuit. It was found here that, as in the case of the three voltmeter method, still greater difficulty was experienced in getting experimental results which agreed numerically well together.

It is not worth while to give all the details of the observations made on the 3,000 watt "Hedgehog" transformer by this one ammeter method. Suffice it to say that, using sometimes an Ayrton and Perry twisted strip ammeter carefully calibrated, and sometimes a Siemens dynamometer, both adapted for measuring from 0.02 to 4 amperes, we obtained such figures as these for the power in watts taken up at no load in the transformer, viz., 116, 116, 183, 154, 100, 164, 176, 119, 124, 200, 113, 71, 79, 79, 67, 108, 87, 76, 103, 88, 100, 80, 88, in 23 different determinations. Curious to say, the arithmetic mean of all these values is [illegible] or almost exactly the same as the mean value obtained from the 20 observations by the three voltmeter method, that the greatest [illegible] from the mean being about the same percentage. The conclusion arrived at with respect to this ammeter method is, that ordinary commercial ammeters do not enable us to determine the currents with anything like the accuracy necessary, when we are operating on open magnetic circuit transformers at no load. It would certainly be necessary to be able to read currents of magnitudes from 0.25 to 5 amperes to the third decimal place, and that is not in general a practicable matter by commercial instruments. After many further trials of this method on different transformers, we were obliged to come to the same conclusions with respect to it as those forced upon us in regard to the voltmeter methods, viz., that it is an unsuitable one for transformers of small power factor, but that with great care and a suitable ammeter it may be made to yield fairly good results on closed magnetic circuit transformers of large power factor. It may be noted in passing that in applying this ammeter method in any case the most favourable condition for accuracy is when the current through the transformer primary is equal to the current through the non-inductive shunt. Hence the shunt [illegible] should be decreased as the load on the secondary of the transformer is increased if we desire to obtain maximum possibility of accuracy in the measurements of the power supplied.

EXPERIMENTS WITH THE DYNAMOMETER WATTMETER METHOD OF MEASURING ALTERNATING CURRENT POWER.

Dissatisfied on the whole with the practical results and difficulties of the voltmeter and ammeter methods, attention was next turned to the employment of the dynamometer wattmeter as an instrument for the measurement of the power given to the primary circuit of transformers. There is no need to recapitulate well known facts about the use of such an instrument for this purpose. It is well understood that a wattmeter or dynamometer with independent series and shunt coils can be used for this purpose provided that the shunt circuit has a practically zero time constant, and the only difficulty which presents itself in passing an opinion on the suitability of any particular form of dynamometer for this purpose is that of knowing whether the shunt circuit really is practically so far free from self-induction or capacity as to make this the case; and this, as our experiments show, must not be taken for granted without investigation. Two wattmeter dynamometers were [illegible]. The first consisted of a Siemens dynamometer of the [illegible] pattern intended to be used as an ammeter for currents from [illegible] to 4 amperes. The fixed coil consisted of a few dozen or so turns of wire, and the movable coil of four turns. We arranged the connections so that it could be used as a wattmeter, the fixed coil being the series coil, and the movable coil of four turns being put in series with 24 100-volt 16 c.p. incandescent lamps, or with two rows of 24 16 c.p. lamps arranged in parallel, and so arranged as a shunt circuit. Contrary to the usual practice we had then a wattmeter in which the shunt circuit carried the larger current. This circuit was traversed by a current of from 1.8 to 2.4 amperes when placed across 2,400 volt mains, according to the group of lamps used.

This dynamometer wattmeter had then a shunt circuit consisting of the 24 series of lamp filaments plus the four turns of wire on the movable coil. It had, therefore, a very small inductance. This wattmeter was calibrated by applying it to measure the known power taken up in our standard resistance. The six coils of our No. 1 resistance, each consisting of about 1,000 ohms, were arranged, two in series and three in parallel, across 2,400-volt mains. The current through these resistances was measured by a Kelvin decimal zero balance, and found to be 2.230 amperes; the P.D. between the mains was measured by a Swinburne voltmeter and found to be 2,400 volts and kept at that value by a regulating transformer with carbon resistances in the secondary circuit, see Fig. 4; and from these measurements the power taken up in the resistance was known. It was [illegible] watts. The dynamometer wattmeter was then arranged so as to measure the known power being absorbed by this resistance, and the constant of the wattmeter thus determined. A torsion of 175deg. of the dynamometer head was found to be required when the resistance was absorbing the above power. This constant was frequently determined. The value was close to 30.4 watts per division of the scale. It will be seen, therefore, that we were employing a wattmeter which, although it absorbed considerable power in its own shunt circuit, had a range of measurement from 12,000 watts down to about 10 or 12 as a minimum reading.

(To be continued.)

The discussion on Prof. Fleming's paper was adjourned to next meeting.

The following candidates were duly balloted for:

Associates.—L. Epstein, Cadby Hall Works, Hammersmith; George Hoit Guy, Temple-court, New York, U.S.A.; William Mow, 74, Commercial-street, Dundee, N.B.

Student.—Fredric Joseph Warden-Stevens, Manor Lodge, Brockley, S.E.

REVIEWS.

Popular Electric Lighting By Captain E. IRONSIDE BAX. Second edition. Illustrated. Biggs and Co.

This attempt to induct the householding public into the mysteries of electric light by sensible and straightforward description and instructions has won the favour of those for whom it was intended, as the appearance of the second edition proves. The new edition is rearranged, and in part rewritten. The technical glossary is relegated to the end and the map of the Westminster district is omitted, making the book more general, and therefore more acceptable to the other supply companies. The advantages of the use of electricity are duly insisted upon, and some very necessary cautions are given against too cheap contracts for wiring. When, however, every person naturally wishes matters to be arranged economically, it is difficult for the householder to judge whether the estimate is too low unless several are obtained. The book therefore gives some specimen estimates. When settling on the position of lamps, Captain Bax suggests the use of a double kerosene lamp to be moved about till good lighting effect is obtained. A useful hint is on the arrangement of switches; careful consideration of their position beforehand will often obviate an otherwise excessive bill, for where the switches turn on several lamps in groups the expense of current will certainly be many times more than really necessary. The diagrams of fuses are plain and easily comprehensible, and the fittings chosen for illustration, though fewer than, perhaps, intending customers would desire, are elegant. The expense of the light is, however, the chief point, and considerable attention is therefore given to the meter question. Estimates, glossary, and list of companies brought up to date, complete this little volume, which is certainly one of the best and most practical of the popular books on house electric lighting.

MOMENTUM AND *VIS VIVA*.

SIR,—In the penultimate paragraph of p. 519, the statement is made that "Momentum signifies the stored up or kinetic energy possessed by a body by reason of its velocity."

This is inaccurate, for *momentum* or quantity of motion (an important value in dynamics), is expressed by $m\ v.$, whereas kinetic energy varies as $m.\ v^2$, or *vis viva*.

I should be sorry to see Mr. Guy's useful work in any degree marred by a *lapsus* which some physicists at least might consider of importance.—Yours, etc.

DESMOND G. FITZGERALD.

CHEAPNESS AND EFFICIENCY.

SIR,—I just notice in your issue of the 18th a remark, in the matter of storage batteries, that "the Electrical Power Storage Company from a business point of view would seem to favour cheapness rather than extreme efficiency."

This class of remark being easily made, although not so easily substantiated, is becoming just a little too common. The Electrical Power Storage Company is quite prepared to supply accumulators taken at random out of its stock at any time, and to have these accumulators tested by independent parties against any type of manufacture at present existing, both for efficiency and durability; and I take it that this is the best answer that the company can make to such questionable means of advertising so-called new inventions by unfair comparison with the company's goods.

Yours, etc., FRANK KING, Manager,
Electrical Power Storage Company, Limited.

London, November 20, 1892.

Louvre Lightning Conductors.—According to the *Petit Journal*, out of 25 lightning conductors which are fixed on the Louvre, there is not a single one in good order. All the rods are broken, or rusty, and are so many danger points instead of safeguards.

WIRE-TO-WIRE ELECTRIC COMMUNICATION.

Some very interesting and important experiments, which have been conducted near Cardiff, under the direction of Mr. W. H. Preece, F.R.S., chief engineer and electrician to the Post Office, have already afforded results which seem to promise the realisation, at no distant time, of the hope, long cherished by electricians, that they may ultimately succeed in transmitting signals to distant points without the employment of intervening wires or other conductors. The methods by which it has been proposed to accomplish this end have been various; but that employed by Mr. Preece has depended upon the utilisation of the induced current, which was first discovered by Faraday, and which is now well known to be excited in a wire by the passage of an ordinary generated current along another wire standing in certain relations to the former. All who are in the habit of using the telephone must have been frequently conscious of the presence of a disturbing element, which usually manifests itself by the production of a sound variously described as resembling frizzling or frying, or as being like the pattering of hail against a window pane, but which sometimes interpolates distinct speech, not belonging to the message which is being designedly transmitted. This possibility of overhearing in one telephone circuit a conversation which is being carried on in another, lowers the value and destroys the privacy of the telephone as a means of communication. The fault depends upon the use of one wire and the earth, instead of two wires, to form the electric circuit. A metallic loop of two wires, abandoning the use of the earth, removes the cause of the indicated disturbances, which are due to the influence which a single wire, carrying an electric current, exerts by induction upon other wires in its immediate neighbourhood. An alternating current in one wire is reproduced by induction in another similar neighbouring wire, but in a diminished degree, the diminution appearing to depend principally upon the distance which separates the two. The extreme delicacy of the telephone has rendered such disturbances audible at very considerable distances. Signals sent through telegraph circuits underground, below the London foot pavements, have been read on telephone circuits above the housetops 80ft. away. Mr. Preece brought the first observed instance of this kind before the British Association, and in subsequent papers he was able to trace similar disturbances to currents which were being transmitted at distances of more than a mile. In a paper read before the association at the Manchester meeting in 1887, Mr. Preece stated that "the distance through which communication can be maintained between ship and ship, between lightship and shore, between islands and the mainland, between the defenders inside and those outside a beleaguered city, becomes simply a question of calculation." Researches with a view to the practical transmission of electricity through space were soon afterwards undertaken in the United States by Mr. Edison; and, especially on account of the great importance of discovering an easy method of communicating between the shore and lightships, Mr. Preece lately obtained the sanction of the Postmaster-General and of the Treasury to the series of experiments upon which he is still engaged. He proposed to conduct them in three different methods—first, by running a wire along the shore on light poles for a distance of about a mile, and a second wire from stem to stern of the ship, the two acting upon each other inductively through the intervening space; secondly, by suspending a short line over the side of the ship, so that it may dip into the sea in the direction of the end of the shore line, to work by conduction through the sea; and, thirdly, by running out a light cable from the shore to the ship, terminating in a coil at the bottom of the sea, near the ship, but not attached to it, while another coil is placed on board. These two coils are expected to act inductively, and to give ample sound on telephones by means of rapid alternations.

The experiments by the first method have been carried to a successful issue within the last few days, the shore wire having been erected along the Welsh coast, commencing at Lavernock Point, a little south of Cardiff, and proceeding for a mile in the direction of Lavernock House. The lightship was represented for the occasion by the island of Flat Holme, in the Bristol Channel; and the line there erected, parallel to the first and three miles distant from it, was about half a mile long. The shore line was furnished with a powerful generator at Lavernock Point, and the island line with a sounder to receive the messages. The result was that the words despatched into the mainland wire were heard on the island with perfect distinctness, and that a communication was thus established between these two points, distant three miles from each other, of a kind which would be absolutely independent of light or darkness, of wind or storm, of fog or rain. The principle underlying this method of communication is precisely analogous to that which governs the transmission of light itself, and by which the illumination of a lighthouse or of a lightship is rendered visible. The researches of modern physicists have led them to the conclusion that, as light is an effect produced by a succession of exceedingly small waves in the generally

pervading ether, so electricity is an effect of the succession of larger waves in the same ether, and that there is probably no other difference between the two than that of magnitude of undulation. We are familiar with a similar difference, but of much smaller degree, between the undulations of light, of heat, and of chemical activity. The solar rays contain all these forms of force, and, if we pass them through a prism, they are all bent or refracted from their original direction to an extent governed by the respective magnitudes of the undulations. Waves which range in magnitude from about 37,000 to about 65,000 to an inch are visible to the eye, and are recognised, the largest as red light and the smallest as violet light, while an intermediate magnitude produces the sensation of green. Waves of greater magnitude than the red, which are invisible, may easily be shown to be sources of heat, while waves smaller than those of the violet, and also invisible, may be shown to be sources of chemical change, and to be the active agents in photography or in bleaching by sunlight. The waves of electricity differ from those of light in being of vastly greater magnitude, so that they recur in hundreds in a second instead of in billions, and also in having a much greater range of magnitude, extending from those just outside the limit of visibility to some of hundreds of feet, or even much more in length. These long waves, moreover, will penetrate many media which are impervious to smaller ones, and the researches of Prof. Tesla have shown how much the penetrating power of electric waves may be increased by rapidity of alternation. Vulcanite, for example, is the best known insulator for the electricity of the ordinary dynamo, or of the ordinary induction coil, either giving a current of about 80 alternations a second; but the Tesla currents, which may reach a million or a million and a half of alternations in a second, will pass through it as if it were not there. The character and the rate of alternation of an electric current will probably be found to exert a considerable influence upon its power of inducing similar currents in distant wires, and one impediment to the application of Mr. Preece's recent work may perhaps arise from the difficulty of generating the currents best suited for the purpose in lightships and other places where they may be required.

Considerable attention was attracted last February by an article on the future of electricity, from the pen of Prof. Crookes, which appeared in the *Fortnightly Review*, and in which the learned author referred to the "bewildering possibility" of telegraphy without wires, posts, cables, or any of our present costly appliances. The suggestions contained in that article proceeded upon lines totally different from that of the utilisation of induced currents, and were based upon the idea that the waves of electricity might be generated of known magnitudes, and then reflected or refracted, like those of light, through or from suitable media, and so directed as to meet in a focus upon a receiving instrument, adjusted to respond to vibrations of such definite magnitude and to no others. Excepting for some chamber experiments to which Prof. Crookes referred, this ground appears to be still untrodden, except that Mr. Edison has suggested the use of captive balloons as intermediate stations, by which a message might be forwarded through space from one to another in such a manner as to overcome the difficulties in the way of direct transmission which would be due to the curvature of the earth's surface. Mr. Edison merely proposed, for this purpose, to use the waves which would radiate from each station in every direction, and not at all to refract or to guide them. Prof. Crookes attached much importance to the generation of waves of definite length, pointing out that a receiver might be constructed that would be dumb to all others, just as the human eye is blind to undulations larger or smaller than those already specified, and he was of opinion that the infinite number of possible wave magnitudes would render it almost hopeless for any unauthorised person—an enemy in time of war, for example—to seek to intercept a message which he was not intended to receive. No one but the sender and the receiver need know the wave length to which the instruments were adjusted, and, without this knowledge, experimental trials might be indefinitely prolonged without success. Even in the method which Mr. Preece is now engaged in developing, it seems not improbable that definiteness of wave length may prove to be an element of great value for the purpose of obtaining the most efficient induction, as well as for the preservation of secrecy. Although generated in a finer medium, there is no reason to doubt that the waves of ether are governed by the same laws as those of air, with which we are familiar as the producers of sound, and it is well known that given sound waves will only excite vibration in a string which is properly attuned to them. It will almost certainly be found that the same principle will apply to the induction of electrical currents, and that precise conditions will be ascertained under which such induction will, on the one hand, attain its maximum, or, on the other, be restrained from occurring. The material through which the primary current is transmitted, the material and the physical condition of the secondary wire or other conductor, and the magnitude and the rapidity of alternation of the electric waves, will all in high probability be important factors in the production of the result. Until all questions of this nature have been completely elucidated, it would be rash to place any limit to the [illegible] to come to the Cardiff trials. The closing months of the year have witnessed easy communication with a receiving instrument three miles distant from the operator, and connected with him only by the ether which occupies interstellar space. It is possible, and not unlikely, that this first achievement may soon be as far surpassed in magnitude and in importance, as the first induced currents exhibited at the Royal Institution by Faraday have been surpassed by the machinery and the applications of the present day.—*The Times, November* 22.

COMPANIES' MEETINGS.

HOVE ELECTRIC LIGHTING COMPANY.

The first meeting of the shareholders of this Company was held on Monday, at the offices, Mansion House-buildings, Great [illegible] Folgate, E.C., in the chair.

In moving the adoption of the report and accounts, the **Chairman** said that Messrs. Crompton and Co., Limited, had very satisfactorily carried out the first portion of their contract with the Company that the temporary station was practically complete. Two miles of mains had been laid, and everything done to the satisfaction of the Hove Commissioners. The actual supply of current was commenced on Saturday. From the number of applications received from customers and other indications, the Directors felt that the future success of the Company was practically assured. Up to the present time applications had been made for [illegible] lamps, and negotiations were in progress for the lighting of the Town Hall and the streets at Hove.

Mr. Albright proposed a vote of thanks to the Chairman, which was seconded by **Mr. Sutton**, and carried.

COMPANIES' REPORTS.

SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

Directors: J. S. Forbes, Esq. (chairman); W. Cuthbert Quilter, Esq., M.P. (deputy chairman); E. W. Batt, Esq.; Major S. [illegible] Page, J. W. Swan, Esq.

Tenth annual report of the Directors, together with a statement of accounts for the year ending 30th September, 1892, presented at the ordinary general meeting of the Company, [illegible] at the Cannon-street Hotel, London, on Tuesday, 29th November, 1892, at 12 noon.

The profit and loss account for the year shows a credit balance of £34,840 11s. 11d., which, together with £8,010 [illegible] brought forward from the last account, makes the [illegible] £42,850 [illegible] 0d. An interim dividend in respect to the first half of the year, amounting to £14,558 [illegible] 8d., has already been paid. The Board propose that a further sum of £21,0[illegible] be divided free of income tax, and that £6,821 17s. 9d. be carried forward. The distribution of this amount in accordance with clause 77 of the articles of association will work out at [illegible] per share on the 78,949 ordinary shares of the Company, £5 [illegible] and at [illegible] per share on the 10,750 £5 fully paid, being equivalent to 10 per cent. per annum on the partly paid and [illegible] that rate upon the fully paid shares. The dividend will be paid upon the register as it stood upon the 15th November, and the warrants will be issued on the 15th December. The [illegible] of the German patents of the Company having happily terminated, and the bulk of the capital of the Company being now [illegible] the Edison and Swan Companies in Great Britain and [illegible], the Board believe that the time has arrived when a [illegible] of the realisation of the foreign business of the Swan Company with the British Edison and Swan Company may be effected with advantage to both interests, and negotiations are pending with a view to effecting some arrangement in this direction. The Directors desire to record their sense of the loss which the Company have sustained by the death of Mr. F. R. Leyland, late chairman of the Company. The Directors have elected Major Samuel Flood Page, who had been secretary and manager of the Company for several years, to a seat on the Board. The Directors who retire by rotation are Mr. J. S. Forbes and Mr. E. W. Batt, who, being eligible, will offer themselves for re-election. Messrs. Welton, Jones, and Co., the auditors, will also retire, and will offer themselves for re-election.

Profit and Loss Account, Year ending Sept. 30, 1892.

Dr.	£	s.	d.
Stock, October 1, 1891	18,44[illegible]	17	7
Purchases	[illegible]	13	[illegible]
Salaries, Directors' fees, rent, office expenses, income tax, general and law charges	[illegible]	17	4
Wages and expenses at factory	[illegible]	6	4
Sales ledger reserve	[illegible]	0	[illegible]
Balance	34,840	11	11
	£63,[illegible]	8	7

Cr.	£	s.	d.
Sales, less commissions and allowances	9,498	1	6
Transfer fees and interest	1,168	16	8
Dividend on shares in La Compagnie Generalé des Lampes Incandescentes, less tax	1,466	11	6
Dividends on shares in the Edison and Swan United Electric Light Company, Limited	37,094	15	8
Stock, September 30, 1892	14,654	3	1
	£63,882	8	7

BALANCE-SHEET, SEPTEMBER 30, 1892.

Dr.	£	s.	d.	£	s.	d.
Share capital—19,750 shares of £5 each fully paid	98,750	0	0			
78,949 shares of £5 each, £3. 10s. paid	276,321	10	0			
				375,071	10	0
Sundry creditors				5,039	9	7
Balance from previous account	8,010	3	10			
Balance Sept 30, 1892	34,840	11	11			
				42,850	15	9
Less interim dividend at the rate of 8 per cent per annum for six months ended 31st March, 1892, paid 31st May, 1892	14,558	9	8			
				28,292	6	1
				£408,403	5	8

Cr.	£	s.	d.
Cost of patent rights, etc., represented by shares in Edison and Swan United Electric Light Company, Limited, with £298,478 paid; shares in La Compagnie Generale des Lampes Incandescentes with £30,489 8s. 3d. paid; patents held by the Company for Germany, etc., as per last balance sheet	332,449	3	5
Less amounts received on account of forfeited shares and costs from the Allgemeine Electricitats Gesellschaft	3,885	11	1
	328,563	12	4
Outlay on factory, plant, etc., as per last account	1,570	9	0
Sundry debtors	3,076	16	9
Stock on hand	14,654	3	1
Investment in Prussian Consols. Cost	5,120	0	0
Investment in new 2¾ per cent. Consolidated Stock. Cost	29,004	19	6
Cash on deposit and in hand	26,413	5	0
	£408,403	5	8

NEW COMPANIES REGISTERED.

Electrical Wonder Company, Limited.—Registered by Beyfus and Beyfus, 69, Lincoln's-inn-fields W.C., with a capital of £10,000 in 9,900 ordinary and 100 founders' shares of £1 each respectively, the founders' shares to receive one half of the net profits of the Company after payment of 10 per cent. dividend on the ordinary shares. Object: to adopt and carry into effect an agreement, made November 4, between E. Cohen of the one part, and H. Felgate, on behalf of this Company, of the other part, for the acquisition of all the rights of the said E. Cohen with respect to the electric Schnelsehr automatic apparatus; generally to carry on business as proprietors of automatic and other machines, and to develop and turn to account the same in such manner as the Company may deem expedient. There shall not be less than three nor more than five directors. The first are A. Schwartz, T. E. Pollen, Count Max Hollender, and E. Cohen. Qualification, 250 shares. Remuneration, £500 per annum, divisible according to attendance at Board meetings, the chairman receiving double fees; when there are more than four directors, an additional £100 per annum for each additional director.

BUSINESS NOTES.

Oxford.—The Electrical Committee of the Oxford Town Council has been discontinued.

Catalogue.—We have received a catalogue of dynamos from Messrs. Statter and Co.

Western and Brazilian Telegraph Company.—The receipts for the week ended November 18 were £2,905.

West India and Panama Telegraph Company.—The receipts for the half-month ended November 15 were £2,139, against £2,314.

Fire Station.—A new fire station, with all the newest appliances, is under course of erection at Dulwich by the London County Council.

Swansea.—At the Swansea County Council a letter was received from Mr. J. C. Howell, Llanelly, applying for permission to lay an electric main from the Alexandra Arcade to the premises of Mr. W. Edwards, draper, Oxford-street.

New Chairman.—Mr. George Herring has been elected chairman of the Electric and General Investment Company, Limited, in succession to the late Duke of Marlborough.

Torquay.—The Torquay Electricity Committee consists of Messrs. R. Crocker, Lorimer, Kerswill, Richardson, Harrison, Smerdon, and the new members for Waldon and Strand.

Newington.—The General Purposes and Lighting Committee of the Newington Vestry recommended at the last meeting that the Vestry should be empowered to supply electric light in the parish, and it was resolved that this step should be taken.

Spanish Submarine.—The numbers are announced of 89 bonds, amounting to £8,900, of the Spanish National Submarine Telegraph Company, Limited, 6 per cent. mortgage debentures drawn for payment at par on December 31 next at the offices, 106, Cannon-street.

City and South London Railway Company.—The receipts for the week ending November 20 were £899, against £792 for the corresponding period of last year, or an increase of £107. The total receipts for 1892 show an increase of £1,640 over those for the corresponding period of 1891.

Greenock Exhibition.—A Marine Industrial and Educational Exhibition opened yesterday at Greenock is lighted throughout with electricity, the installation comprising 20 arc lamps, besides a large number of incandescents, and over 20 miles of wire has been used in wiring the exhibition.

Barnet.—At the Barnet Local Board meeting it was reported that the draft memorial to the Board of Trade had been presented. A letter from Messrs. Ingledew, Ince, and Colt, solicitors to Mr. H. F. Joel, with reference to the provisional order in the matter of the electric light, was considered in committee.

Arlecdon.—At the Arlecdon and Frizenball Local Board, the question of water power and electric light was again raised. Mr. Boyd found the pressure in the town insufficient to use. Mr. Richards suggested Ehen Beck. Mr. Toye thought they should wait and see how Whitehaven got on, and the question was eventually held over.

Holborn Installations.—We understand that Messrs. Vaughan and Brown, of 16 and 17, Kirby-street and Farringdon-road, E.C., have installed the electric light at Sexton's Repository, Central Hall, Holborn, with 600 lamps; the Palace Theatre with about 1,000 extra lamps; also The Blue Posts Hotel, Tottenham Court-road, and The Flying Horse, Oxford-street.

Wycombe.—The Wycombe Corporation have decided not to proceed this session with the application for a provisional order to supply electricity. This conclusion was come to at the meeting held *in camera* for the selection of the mayor. The cost of the order was estimated at over £200, and hesitation was evinced in authorising the spending of this sum at the present juncture.

Electric and General Investment.—The Directors have declared an interim dividend at the rate of 20 per cent. per annum for the six months ending November 30, 1892, on the capital paid up on the ordinary shares of the Company, the same to be payable on and after December 15 next, and it is notified that the transfer books of this company will be closed from December 1 to 15 inclusive.

City of London Electric Lighting Company, Limited.—This Company furnish particulars of the present position of their capital. The authorised share capital is £400,000 in £10 ordinary shares, and £400,000 in £10 6 per cent. cumulative preference shares. Of these there have been issued £400,000 ordinary shares (fully paid), £200,000 preference shares (£4 paid, next call of £9 due January 16, 1893).

Northampton.—At the meeting of the Northampton Town Council last week the Highway, Lighting, and Building Committee stated that they had inspected the electric light on the Market-square fountain, and Mr. Beale, engineer to the Northampton Electric Light and Power Company, had been asked to send to the committee the cost of lighting the square. The report was adopted.

Consulting Engineer.—Mr. Edwin Blakey has lately severed his connection with Messrs. Blakey, Emmott, and Co., Limited, with whom he has been identified for many years, and is now practising as a consulting engineer and electrician at 27, Taufield-chambers, Hustlergate, Bradford. His long experience in electrical matters will enable him to undertake important work, and we wish Mr. Blakey every success in his new departure.

Dundee.—The first meeting of the Dundee Gas Commission, as now constituted, was held last week. The engineer submitted a report which bore that up to date current had been applied for for 870 lamps of 16 c.p., or their equivalent, and that the engineer had been informed of 300 more. This is in addition to arc lights, of which about 16 are applied for. It was agreed to fix the meter rents on a scale of 12½ per cent. on the cost of the meters.

Siam.—The Brush Electrical Engineering Company, Limited, have received advices by cable from their representatives at Bangkok that the central station plant supplied by them to the Siam Electric Light Company has undergone the fortnight's trial prescribed by the arbitrators under their award, with complete success and to the entire satisfaction of the experts, and that the balance of moneys due thereon has been paid over by the Treasury.

Worcester.—At the meeting of the Worcester Watch Committee last Friday, it was resolved to recommend the City Council to purchase Powick Mills, on the River Teme, for the purpose of electric lighting, at a cost of £5,000, and to accept an alternative tender by the Brush Company amounting to £23,209. It was

stated that by utilising the water power of the Teme for generating the electricity a saving of £1,116 per annum would be made.

Blackpool Electric Tramway.—The Blackpool Corporation have decided to extend the electric tramway which has been such a prominent feature of their promenade. It is intended to carry the line round Whitegate-lane, Marton, from thence along Common-lane to South Shore, where it will join the existing line. A new company is in process of formation to construct a similar system of tramways between South Shore, St. Anne's, and Lytham.

Incandescent Electric Lamps.—The Edison and Swan Company are advertising with reference to the statement made in the circulars of foreign lamp makers which are now being circulated in this country, to the effect that the company's lamp patents are now at an end, that such statement is incorrect, and they give notice that legal proceedings will be taken against all users of lamps other than those manufactured by the company and marked with their name.

Glasgow.—The work of completing the installation for the lighting of the streets in the central districts of Glasgow by electricity is being rapidly pushed forward, and already the iron conduits in which the wires are placed have been laid underneath the foot pavements in many of the principal thoroughfares. The lamp pillars for the new light will stand over 21ft. high, and as a first instalment 106 of these lamps are to be fitted up. The pillars will be placed at the kerb of the foot pavement.

Launch of a Telegraph Steamer.—On Saturday there was launched from the yard of Messrs. Ramage and Ferguson, Limited, a steamer built to the order of the Western and Brazilian Telegraph Company, Limited, London. The principal dimensions are 220ft. by 31ft. by 23ft. 3in. mld. depth, with triple expansion engines. The vessel will be completely equipped with all the most modern appliances for cable laying and lifting purposes. On leaving the ways the steamer was named the "Norseman" by Mrs. Ramage, The Hawthorns, Bonnington.

Clapham-Paddington Electric Railway.—In the ensuing session of Parliament a Bill is to be introduced with the object of seeking powers for the construction of an underground electric railway commencing at a point in close proximity to Clapham Junction, and passing thence via South Kensington to a point near the Great Western Railway Company's terminus at Paddington. The proposed railway appears to be an extension in the direction of Clapham Junction of the South Kensington and Paddington Subway scheme, which was promoted in 1891, but withdrawn before it was considered by a Select Committee.

Overhead Wires at Guildford.—At the meeting of the Guildford Urban Sanitary Association last week, a correspondence which had passed between the London and South Western Railway Company and the Board of Trade, with reference to the proposed by-laws relating to overhead wires, was read by the clerk. The company requested that they might be heard on the subject before the by-laws were confirmed. The Board of Trade asked to be furnished with the Authority's observations on the matter. On the motion of Mr. F. Wheeler, seconded by Mr. E. H. Hitchcock, the question was referred to the Paving and Lighting Committee.

City Lighting.—A letter was received at the meeting of the Commissioners on Tuesday from the City of London Electric Lighting Company relative to the progress made in lighting the City by electricity. They stated that out of 515 arc lamps contracted for in the principal streets, 409 had been supplied, some of them three months before the contract time. Of the remainder, the positions of 44 had not yet been definitely fixed, but the rest would be completed as soon as the operations retarding them, for which they were not responsible, such as the repaving of streets, were finished. They were now prepared to go on with the erection of the incandescent lamps in the smaller streets.

Windsor.—Mr. Thomas Dyson, writing to the *Windsor Gazette*, admits that to raise the head of water from the river would be most detrimental to the water service of the town, but to utilise the "tails" of our streams, now running to waste, which he hopes will be done some day, with any water power they may have to spare, would be a stroke of wisdom and a profitable transaction. The generating of electricity by water power at the water works dates to my knowledge as far back as 1884, and he thinks that if Mr. Cutler had continued to be the proprietor of the water works, something would have been done ere this, to use the valuable element—"Heaven's free gift"—that lies at their feet night and day.

Town and County Installations.—Among the important contracts lately obtained by Messrs. Drake and Gorham, in London, we observe the lighting of the residence of the Right Hon. Baron Henry de Worms, M.P., at 42, Grosvenor-place; the London residence of Sir E. H. Carbutt, Bart., at 19, Hyde Park-gardens; also 54, Lowndes-square, for Mr. Nicholas Wood; 6, Moorgate-street, for Messrs. Schwann Bros.; and they have just completed 65, Old Bailey, for Messrs. John Dickinson and Co. We also understand that they have in hand several country house installations, amongst which we may mention those for Sir Gervase Glyn, at Ewell, Surrey; J. Hallett, Esq., at Orpington, Kent; and R. Hermann, Esq., at Cambridge.

Newington.—At the meeting of the Newington Vestry last week Mr. Cole moved the following recommendation of the General Purposes and Lighting Committee: "That having regard to the financial success attending the electric lighting in the parish of St. Pancras, this Vestry is of opinion that if a competing supply is considered expedient in this parish, the Vestry should be empowered to provide that supply, and not another public company; and entertaining this view, the application before the Board of Trade by the County of London Electric Lighting Company, Limited, for a provisional order under the provisions of the Electric Lighting Acts, 1882 and 1888, be opposed." After some discussion the motion was carried unanimously.

Barry Island Electric Railway.—In a parliamentary notice just issued, the Barry Dock and Railways Company give particulars as to the Bill for proposed electric tramway. The Bill provides for a tramway situate in the parishes of Barry, Merthyr Dovan, and Sully, commencing in the parish of Barry, at a point where the company's approach road to the Barry Station joins the road leading to Barry Harbour, extending thence along the said station approach road, thence in a north-easterly direction along part of Barry Dock road, and thence in a southerly direction over the company's western embankment to Barry Island and along Paget road, terminating in Paget road, near the beach of Whitmore Bay on Barry Island—a second tramway being situate wholly on Barry Island.

Fire Insurance Policies.—"A Solicitor" has the following letter in the *Times* of the 22nd inst., which it will be well for electrical companies and contractors to note: "Sir,—The recent fire in Regent-street, which, as I understand from the published accounts, is officially ascribed to 'overheating of electric wires,' is a fitting opportunity for directing attention to the question whether premises electrically lighted and their contents are covered by the ordinary fire insurance policies. I think it would be well for you to advise all persons who are having the electric light installed to get their existing fire policies endorsed by the offices 'electric lighting allowed,' otherwise, if a fire occurs, they may be met with a contention that they have added a new risk to the insurance which is not covered by the policy."

Cologne.—The cost of the Cologne installation for 20,000 lamps has amounted to £92,500, composed as follows: Buildings, machine room, boiler room, shaft, offices, £18,250; 10 boilers, £5,500; engines, dynamos, and switchboards, £32,500; mains and transformers, £31,000; meters, £2,000; works and various buildings, £2,500. The price of the installation per lamp is thus £4. 12s. 6d. The transformers reduce the pressure from 2,000 to 72 volts, varying from $1\frac{1}{4}$ to 25 kilowatts. The difference of potential between full and light load is about 2 per cent. The loss by hysteresis is: for $1\frac{1}{4}$ units 3.3 per cent., $2\frac{1}{2}$ units [illegible] per cent., 5 units 2 to 2.2 per cent., 10 units 1.7 to 2 per cent., and 25 units 1.2 per cent. The price of sale is equal to 9.6d. per unit, equal to ½d. a hour per 16 c.p., and 3½d. a hour for an arc lamp of 400 c.p. taking 350 watts, with discount for large quantities.

Proposed New Cable.—The Brazilian Submarine, the Western and Brazilian, and the West Coast of America Telegraph Companies, Limited, offer to the shareholders of their respective companies an issue at 102 per cent. of £100,000 4 per cent. guaranteed £100 debentures of the Pacific and European Telegraph Company, Limited. The debentures, which will be registered, are payable at the expiration of 50 years, but the company retains the right to pay them off at an earlier date at the price of £110. The proceeds of the debentures will be applied towards the maintenance and construction of a line of telegraph wires between Buenos Ayres and Valparaiso, with a branch between the latter place and Santiago, the capital of Chili, under concessions granted by the Argentine and Chilian Governments, thus, by means of the Montevideo and Buenos Ayres lines of the River Plate Telegraph Company, Limited, with which the Western Brazilian Company have a traffic arrangement, connecting the existing [illegible] and duplexed system of the Brazilian Submarine and Western Brazilian Companies with the cables of the West Coast Company, [illegible] between Valparaiso (Chili) and Lima (Peru).

Belfast.—The attention of Belfast has lately been directed to the question of electric lighting, and especially its adaptability to, and cost of production in, mills and factories have been favourably discussed by lecturers and writers in the press. A case in point is the adoption of the electric light in the York-road Mill of the York Street Spinning Company, Limited, of Belfast. In this mill an installation of 65 32-c.p. and 20 16-c.p. incandescent lamps, together with dynamo, has lately been erected and successfully set to work by Messrs. W. H. Allen and Co., of York-street, Lambeth, London. The dynamo has an output of 65 volts and 150 amperes when running at a speed of 700 revolutions per minute, and is furnished with a fast and loose pulley and a [illegible] or outer standard, with belt-tightening gear. The switchboard and connections are so arranged as to permit of the easy extension of the installation. The insulation of the cables and fittings is specially adapted to withstand the effects of the hot, damp atmosphere of the spinning room, and throughout the utmost care has been taken to adapt the method of lighting to the [illegible] of the case. The whole installation affords a fine illustration of modern mill lighting.

Reading.—Notice is given that application will be made to the Board of Trade on or before the 21st day of December next, by the Reading Electric Supply Company, Limited, a company registered under the Companies Acts, 1862 to 1890, with limited liability, and having its registered office at 2, Hungrave-street, Reading (hereinafter called the "undertakers"), for a provisional order (hereinafter called the "order") under the Electric Lighting Acts, 1882 and 1888. The following are the names of the streets within which the undertakers propose to lay down electric lines within a period of two years from the commencement of the order: [illegible] street, Broad street, Butter Market, Castle street, Duke street, Friar street, Gun street, High street, King's road (to where

Queen's-road joins it), King street, London-road (to where King's-road joins it), London street, Market place, Minster street, Oxford road as far as Howard-street, St Mary's Butts, West street. A map showing the boundaries of the area of supply will be deposited on or before the 30th day of November, 1892, for public inspection with the clerk to the local authority, at his office at the Town Hall, Reading, and with the clerk of the peace for the borough of Reading, at his office at 165, Friar street, Reading; and with the clerk of the peace for the county of Berks, at his office at 17, Friar street, Reading. Any objection must be addressed to the Board of Trade by January 15, 1893, and a copy must be served to either of the solicitors, H and C Collins, 2, Blagrave street, Reading; or Henry F. Kite, 11, Queen Victoria street, London, E.C.

Exeter. -At Exeter City Council last week, a letter was received from the Board of Trade, requesting to be furnished with any observations the authority might have to offer on a communication made to the Board by the Exeter Electric Light Company. The company are the undertakers to the Exeter Electric Lighting Order, 1891 and stated that the Council had recently had an application from the proprietor of two hotels within the area of supply mentioned in the order, for liberty to break up the public street between the two establishments, for the purpose of laying down an electric main. The Council decided to offer no objection thereto provided the roadway was restored to the satisfaction of their surveyor. The directors of the company did not think it fair that permission should be given to break up the public streets and lay down electric mains to anyone who chose to apply. They understood the Board of Trade had been advised that local authorities had no power to grant such permission to persons or companies holding any license under the Electric Lighting Acts. If this was the case, they asked that the fact might be communicated to the Council. It was decided to acknowledge the receipt of the letter without offering any observations upon it. Another letter from the secretary to the company informed the Council that a cheque for £350, on account of the claim for breaking up the streets for the purpose of laying the electric mains, had been paid to the city treasurer. Alderman Daw asked if the mains had been completed, as the sooner the poles were removed the better it would be for the town. The town clerk said he only knew that some of the overhead wires had been taken down.

Parliamentary Notices. -The issues of the *London Gazette* just lately have been filled with parliamentary notices of various kinds, some of which are of interest to electrical engineers, such as

BOLTON.—For the power to obtain the tramway system and to work it by any suitable method, electrical or otherwise.

NEWCASTLE ON TYNE.—To obtain a provisional order to authorise the Newcastle on Tyne Electrical Supply Company to extend their area.

BLACKPOOL CORPORATION.—Provisional order for extension of tramways.

GOOLE.—To authorise the Goole and District Gas Company, among other things, to obtain powers as to the supply of electricity.

THE LONDON COUNTY COUNCIL.—To take general powers as regards electric lighting, the words in the *Gazette* notice being: "To confer on the Council all necessary powers to enable them to provide and maintain an electric lighting installation on the Victoria embankment and the gardens thereon, and on the Westminster and Waterloo Bridges and neighbouring places, and for that purpose to empower the Council to generate and store electricity, and to use any lands for the time being belonging to them, and upon such lands to erect and maintain any necessary workshops, engine houses, storehouses (including places for storing electricity), or other buildings, and to manufacture, buy, or hire any machinery, steam engines, gas engines, or other apparatus and to take, hold, and use patent rights, or licenses, or authorities under letters patent for the use of inventions relative to the generation, utilisation, distribution, or supply of electricity or other lighting agent."

GLASGOW.—In relation to tramways and to telephone and telegraph wires.

Electric Tram Traction for Birmingham. The following is from the *Birmingham Daily Post*. "The opening of a line of electric tramway in South Staffordshire worked on the overhead wire principle, has revived the discussion as to whether it would be wise to allow the Central Tramways Company to substitute such a system of working for the use of steam on some of their lines. The overhead wire was thought objectionable on the Bristol road route because of its unsightliness, because it would have interfered with some of the trees and because electric wires carried in this fashion are often dangerous. Two of these objections would not, perhaps, apply in the same degree to a proposal to use it on certain other routes, and the objection founded on considerations of public safety appears to have been met in South Staffordshire in such a way as to satisfy Major General Hutchinson, the representative of the Board of Trade. In view of the congratulations offered by that gentleman to Mr Dickinson, engineer and general manager of the South Staffordshire Tramways Company, Mr Ebbsmith, chairman of the Birmingham Central Tramways Company, thinks it prudent to keep an open mind as to the advisability of using electric instead of cable traction on those routes which are affected by his recent proposals to form separate companies. If, he says, it could be used by means of an overhead wire, the Central Tramways Company would be 'a gold mine.' Cable traction is, of course, an economical thing to use, but the objection to it, especially in the present condition of affairs, is that it involves a large initial expenditure and a prolonged disturbance of the street surface, and consequent suspension of the company's traffic. The introduction of the overhead electric system is by comparison a cheap and simple matter. We understand that the Mayor and the Public Works Committee will be invited to visit Darlaston when the new service commences, so that they may judge how far it is adaptable for introduction in Birmingham. The safety of the system from an electrical point of view appears to be assured. The current is one of 300 volts only, and is continuous, not alternating. Mr. Edison has expressed the opinion that only under exceptional conditions can a current of 1,000 volts prove fatal; and Mr Dickinson states that while in Boston he saw a man take a current of 500 volts for the reward of a pint of beer, and that he did not seem to be dangerously or very painfully affected. But in order to meet any objection on this head, Mr. Dickinson has devised an arrangement by which the current ceases as soon as the wire breaks."

Electrical Trades' Union. -The head office of the Electrical Trades' Union established 1889, is at The Clarence Hotel, Aldersgate street, London, E.C. General secretary, A. J. Walker, 19, Claude road, Peckham, S.E.; president, Thomas Cannon, 1, Pullen buildings, Penton place, S.E.; executive council, H. Cork, T. Foster, W. Gooday, A. Hines, J. Moon, A. Norman, C. Thirlwell, W. Tabb. The union has now 28 branches, comprising 1,700 members. Branches are established in the following places: City of London, Manchester, Liverpool, Leeds, Dewsbury, Sheffield, Hanley, Bradford, Boston, Halifax, Croydon, East Greenwich, Kensington, Lambeth, Belfast, Preston, Glasgow, Newcastle on Tyne, Sunderland, Middlesbrough, West Hartlepool, Huddersfield, Nottingham, Derby, Blackburn, Salford, Hull, Leicester, Cardiff, Silvertown. Branches will be opened in the following towns shortly: Wolverhampton, Birmingham, Portsmouth, Devonport, Bristol. The benefits of this union are thus described: Out of work benefit, 2s per day, or 12s per week for 12 weeks; contingent benefit, special rates of pay for special cases; accident benefit, 10s. per week for 14 weeks, 7s. per week for a following 14 weeks; funeral benefit, on the death of a free member, £10, member's wife's death, £5; member's donation benefits are paid while on travel, and members are relieved from branch to branch. The entrance fee is 2s 6d, payable 1s on nomination and 1s. 6d on initiation, the contributions being 6d per week. This trades union was established in November, 1889. It was amalgamated with the Telegraph and Telephone Construction Men in December, 1890. The purposes for which the union was instituted are thus given: 1. For resisting any attempt to curtail or take away any of those privileges which are or may become the custom of the trade. 2. For assisting our members in recovering wages in dispute and obtaining justice against any unfairness practised towards them in their occupation. 3. For helping the members to obtain employment. 4. For giving relief to members when out of employment, or in distress, or in cases of accident whilst in the exercise of their calling, and paying a certain sum in the event of death. 5. For regulating the relations between workmen and employers. The following are eligible who are competent in one or more of the following branches: Armature magnet and transformer winders; erectors and tenders; installation linesmen and wiremen, indoors and out; battery accumulator makers, fitters, and inspectors; telegraph and telephone wiremen and linesmen faultfinders; instrument makers, installation attendants, land or sea, electrical traction employés, also labourers who have been employed for six months and upwards, whether telegraph, telephone, or electric light construction and maintenance.

Scarborough. -The Scarborough Electric Supply Company, Limited, has been formed with a capital of £50,000 in 5,000 shares of £10 each. The first issue has been made of 2,000 shares of £10 each, payable £2 on application, £2 on allotment, and the balance by instalments of £2 at intervals of not less than one month. The Directors are Lieut Colonel R F Steble, J.P., Ex Mayor of Scarborough; G. Alderson Smith, Esq., J.P., chairman of the Grand Hotel Company, Limited, and director of the Cliff Bridge Company, Limited, Scarborough; John Dale, Esq., J.P., Mayor of Scarborough; John Woodall Woodall, Esq., M.A., F.G.S., J.P., C.C., banker, Scarborough; George Lord Beeforth, Esq., J.P., Scarborough; John Bell Simpson, Esq., J.P., Hedgefield House, Blaydon on Tyne, director of the Newcastle and District Electric Lighting Company, Limited; the Honourable Charles A. Parsons, managing director of the Newcastle and District Electric Lighting Company, Limited; A. A. Campbell Swinton, Esq., Assoc.M.I.C.E., M.I.E.E. Managing director and consulting engineer: A. A. Campbell Swinton, Esq. Bankers: Messrs. Woodall, Hebden, and Co., Scarborough; Messrs. Lambton and Co., Newcastle on Tyne. Solicitors (*pro tem.*): Messrs. Leadbitter and Harvey, Newcastle on Tyne. Secretary (*pro tem.*): John Hall, Esq., 102, Westborough, Scarborough. Temporary Offices: 102, Westborough, Scarborough. The Company has been formed for the purpose of supplying electricity for lighting, motive power, and other purposes, in the town of Scarborough. The Corporation of Scarborough in the year 1891 obtained a provisional order (which was duly confirmed by Act of Parliament) enabling them to supply electricity within the borough of which they are the sanitary authority. It was, however, ultimately determined to transfer to other parties the powers, duties, and liabilities granted and imposed by the provisional order. Negotiations ensued, the result of which was that arrangements were entered into by the Corporation with Mr. A. A. Campbell Swinton, electrical engineer, of 66, Victoria street, Westminster, for the transfer to a company to be formed by him of the powers, duties, and liabilities of the provisional order. The Company has accordingly been formed for the purpose of providing the necessary capital, and the transfer will be made direct from the Corporation to the Company,

with the consent of the Board of Trade. The terms arranged with the Corporation comprise power for the Corporation to purchase the undertaking at the end of 21 years, 32 years, or any subsequent completed period of five years. If the Corporation exercise their option of purchase at the end of 21 years they are to pay the value of the undertaking as a current going concern, but without any allowance for compulsory purchase. If the option be exercised by them at the expiration of 32 years, or any later period, they are to pay for the undertaking the fair market value of all lands, buildings, works, materials, and plant suitable to and used for the purposes of the undertaking, regard being had to the nature and condition of such buildings, works, materials, and plant, and to the state of repair thereof, and to the circumstance that they are in such a position as to be ready for immediate working, and to their suitability to the purposes of the undertaking. The Company will pay to the Corporation the sum of 500 guineas to cover the expenses incurred by them in obtaining the provisional order. The maximum price of electricity for private consumers will be 7d. per Board of Trade unit, and for street lighting will be 6d. per unit. The price is to be reduced according to a specified sliding scale, which will not, however, come into effect until a cumulative dividend at the rate of £8 per cent. per annum has been paid to the shareholders. It is estimated that an expenditure of not more than £20,000 will be required to enable the Company to commence operations on a proper scale, and it is expected that the light will be turned on not later than the beginning of June next. It is proposed that the Company shall be worked upon the same lines, and with the same electrical system as the Newcastle and District Electric Lighting Company, Limited, of which the Hon. Charles A. Parsons, who is a Director of the Scarborough Company, is managing director. The Newcastle Company, which has only been in active operation a little more than two years, paid last year a dividend of 5 per cent. on its ordinary shares, besides placing a considerable sum to reserve and depreciation funds. The Directors have obtained the refusal of several suitable sites on reasonable terms. The Company will pay the expenses incidental to its formation, but no promotion money will be paid, and there will be no founders' shares. By the terms of the provisional order, the transfer to the Company must be effected by deed approved by the Board of Trade. The draft deed has been prepared, and a copy has been deposited at the office of the town clerk in Scarborough, according to the conditions of the provisional order. The Directors will themselves take not less than one-fifth of the first issue of shares. Applications for shares should be made not later than the 3rd December next.

PROVISIONAL PATENTS, 1892.

NOVEMBER 14.

20538. **Improvements in electrical cash or small parcel carriers.** James Heath Nicholson, of the firm of R. Waygood and Co., 17, Baronet road, Tottenham, London.

20590. **Means and electrical apparatus for preventing and killing blight on vegetation.** Robert Henelade Courtenay, 11, Lambourne road, Clapham, London.

20598. **Improvements in and relating to the manufacture of electric accumulators.** Charles Theryc and Alfred Oblasser, 45, Southampton buildings, Chancery lane, London.

20602. **Improved construction of electric bell push.** Charles Britcher, 9, Warwick court, Gray's inn, London.

20603. **Improvements in the fastenings of windows, doors, and other similar devices, and in electrical switches connected therewith.** David Lionel Salomons, 1, Queen Victoria-street, London.

NOVEMBER 15.

20606. **Improvements in electric arc lamps.** Charles Aubrey Day, 321, High Holborn, London. (The Higham Electric Company, United States.) (Complete specification.)

20610. **Improvements in telephone circuits.** George Lee Anders and Walther Kottgen, 10, Jeffrey's square, St. Mary axe, London.

20611. **Improvements in governing electric motors.** Benjamin Joseph Barnard Mills, 23, Southampton buildings, Chancery lane, London. (Robert Lundell, United States.) (Complete specification.)

20621. **Improvements in electric burglar alarms.** Homer Tong Wilson and Nathan Schwab, 4, Corporation street, Manchester. (Complete specification.)

20641. **The carriage electric light apparatus.** George Murray, 1, King street, Westminster, London.

20666. **An improved electromagnetic alarm or call.** Parnell Rabbidge, 6, Bream's buildings, Chancery lane, London.

20670. **Improvements in the arrangement of telephone circuits and switching devices therefor.** Sir Charles Stewart Forbes, Bart., 21, Finsbury pavement, London.

20693. **Improvements in electric arc lamps.** Fritz Hansen, 46, Lincoln's inn fields, London. (Complete specification.)

20698. **An improved electric arc lamp.** Henry Hungerford Boyle, 9, Warwick court, Gray's inn, London.

20700. **Improved means for lighting trains by electricity.** *Daniel Jones*, 9, Warwick court, Gray's inn, London.

NOVEMBER 16.

20729. **Improvements in dynamo-electric machines.** John Augustine Kingdon and Woodhouse and Rawson United, Limited, 88, Queen Victoria street, London.

20789. **A method of and apparatus for transmitting vocal and other sounds electrically.** James Geneve Lorrain, Norfolk House, Norfolk street, Strand, London. (Charles Clamond, France.)

20792. **An improved watchman's electric time recorder.** William Wilson Horn, 151, Strand, London. (Emanuel R. Heyser, United States.)

NOVEMBER 17.

20864. **Improvements in telephone transmitters.** Robert Peblitz, 76, Chancery lane, London. (Complete specification.)

20894. **Improvements in and relating to telegraphic or telephonic call systems.** Herman Wetzer, 18, Buckingham street, Strand, London. (Complete specification.)

20900. **An improved process of manufacturing and depositing spongy lead for secondary or storage batteries or receivers.** Ernest Bailey and John Dunham-Massey, 45, Southampton-buildings, Chancery lane, London.

20901. **Improvements relating to the electric lighting of railway carriages and other vehicles.** Ernest Bailey and John Dunham-Massey, 45, Southampton buildings, Chancery lane, London.

NOVEMBER 18.

20912. **Improvements in or connected with telephone apparatus.** Ridley James Urquhart, 5, Clayton square, London.

20959. **An improved electric arc lamp.** Frank West Suter and Sydney John Suter, 28, Southampton buildings, Chancery lane, London.

20964. **Improvements in electrical relays and apparatus for telegraphing to lighthouses either floating or on rocks at a distance from the shore or for telegraphing to and from vessels.** Willoughby Statham Smith and William Paddicombe Granville, 24, Southampton buildings, Chancery lane, London.

20989. **The detachable electric light bracket.** Albert Warren Upcraft, 5, Great Woodstock street, Marylebone, London. (Complete specification.)

NOVEMBER 19.

21020. **An electric-governed night latch.** Edwin Ward, 6, Argyle road, Nichol's Town, Southampton.

21041. **Improvements in and connected with electrometers and in their application to electric tramcars and locomotives.** John Augustine Kingdon, 20, Marlborough hill, London.

21074. **Improvements in galvanic batteries.** Frederick Culver James, 9, Quality court, Chancery lane, London.

21083. **Means for measuring or comparing sounds produced with telephones by the transmission of electric currents over a circuit.** John Edward Kingsbury, 24, Southampton buildings, Chancery lane, London. (The Western Electric Company, United States.)

SPECIFICATIONS PUBLISHED.

1892.

37. **Electric tricycles, etc.** Webb.
14886. **Electric switches.** Wright.
15059. **Electric incandescent lamps.** Glover.
17222. **Electric metal working.** Thompson. (Coffin.)
17226. **Welding metals electrically.** Thompson. (Coffin.)
17227. **Welding metals electrically.** Thompson. (Coffin.)
17242. **Electro-medical appliances.** Newton. (Carruthers.)
17304. **Electric heaters.** Ahearn.
17321. **Electric water heaters.** Ahearn.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	Price Wednesday
Brush Co.	—	3½
— Pref.	—	[illegible]
City of London	—	[illegible]
Electric Construction	10	3¼
Gatti's	—	[illegible]
House to House	5	5¼
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]
London Electric Supply	[illegible]	[illegible]
Metropolitan Electric Supply	—	[illegible]
National Telephone	[illegible]	4½
St. James'	—	[illegible]
Swan United	3¾	[illegible]
Westminster Electric	—	5½

NOTES.

Edison Lamp Patents.—The Edison companies are proceeding for an injunction against the Sawyer-Man Company.

Durham College of Science.—The foundation-stone of the new buildings of this college will be laid by the Earl of Durham on Monday next.

Church Lighting.—The Benedictine Abbey of Fort Augustus has the claim made for it as being the first Roman Catholic church lighted by electricity in the British Isles.

Junior Engineering Society.—A paper will be read before this society at the Westminster Palace Hotel on 2nd December by Mr. H. Fraser, on "Water-Tube Steam Boilers."

Niagara Observatory.—It is proposed to erect a steel observatory, 250ft. high, at Niagara Falls. Electricity will be largely used for the lifts and for the illumination.

Austrian Telephones.—The long-distance telephone line opened in October between Vienna, Gratz, and Trieste, in Austria, is the longest in Europe after that from Paris to Marseilles.

Chicago.—Correspondence from Chicago assures us that it is not, and never has been, the intention of the Chicago Exhibition authorities to close early in the evenings on weekdays.

Khotinsky Accumulators.—Captain Khotinsky is giving an exhaustive biographical account of the development of his accumulator in the pages of the New York *Electrical Engineer*.

Society of Arts.—Mr. James Dredge will read a paper before the Society of Arts on "The Chicago Exhibition" on Wednesday next, December 7, at 8 p.m. Sir Philip Cunliffe-Owen will preside.

Mains.—The question of underground mains is becoming a serious one in Paris, for we understand that more than one company have had to decide to reinstal the whole of their underground network.

Erba Prize.—The president of the Italian Electrical Society announces a prize of 500 lire with gold medal, to be awarded on January 10th, for a paper on "Comparative Study of the Bipolar and Multipolar Dynamo."

Speed and Power.—Sir Robert Ball calculates that if a spider's web belt travelled at the speed of light it would transmit 250 h p. If we can only get hold of the molecules—on Tesla's or other plan—what power may not be at our command

Smoking Concert.—Upwards of 100 of the London employés of the firm of Messrs. Drake and Gorham held their first smoking concert for the season on Wednesday evening. An excellent programme was provided, and a very enjoyable evening was spent.

The Hopkinson Case.—The suit of Hopkinson *v* The St. James and Pall Mall Electric Light Company has been again before the Courts, Mr. Moulton, Q.C., finishing his reply on behalf of the plantiff. Mr. Justice Romer said he would take time to consider his judgment.

Series Traction.—Mr. J. T. Sprague, speaking in a discussion at the American Institute of Electrical Engineers, said: "The series system of electric traction is absolutely dead in America, as in England. Mr. Short tried it a few years ago in Denver and West Virginia. It is now dead."

Skating by Arc Light.—Bitter cold prevails at Vienna, and the large skating-place behind the Art Museum is a brilliant scene by day and night with crowds of skaters, for in the evening 30 arc lamps are lighted, and the skimming figures glide here and there to the waltzes played by the military band.

Electric Pumping.—A paper was read by Mr. Maurice Deacon on "A Small Electric Pumping Plant" last January before the Chesterfield and Midland Counties Institution of Engineers. A discussion will be held on Saturday, the 3rd inst., on this paper, and also on the "Use of the Telephone," by Mr. F. S. Marsh.

Ozonators.—A Press view has been held in Liverpool to test Leather's ozonator and purifier—an apparatus fitted with an antiseptic chamber through which air is driven by an electric fan. The invention is stated to be used very largely for ventilating in the United States, and is being introduced into London and other large cities.

Two Motors or One.—Prof. Shepardson (America) says that a series of 12 tests on an electric tramway showed that 27 per cent. less current is used on the cars driving by one motor than when driving by two. The difference is attributable to the two being necessarily mostly at light load and lower efficiencies—also to the difficulty of running exactly together.

Local Electrical Industry.—We notice that the local papers are more and more taking to describing technical industries in their neighbourhood, great interest being taken in all electrical subjects. The Plymouth papers, for instance, this week describe the electroplating establishment of Messrs. Brock and Co., where a gas engine and dynamo are used for electroplating.

Electric Light for Balloons.—Some experiments of lighting the ground by means of balloons furnished with projectors of 5,000 c.p. have recently been carried out in Russia at the height of 2,000ft., and in spite of a thick mist the rays of electric light covered a surface of about 1,600ft. diameter. At 500ft. high a luminous ray could be projected fully lighting three-quarters of a mile of the route.

Overland Telegraph to Egypt.—Mr. Rhodes, at the meeting of the British South Africa Company, dealt with the question of an overland telegraph to Egypt. He had made a proposition to the Government that he would take a line through to Uganda at a cost of about £150,000. They would then be able to send messages at 1s. per word to Egypt and 1s. 6d. thence, instead of 9s. 6d. now charged by the cable companies.

Electric Heaters.—We have received a well illustrated list of Ahearn's electric heaters from the Railway Equipment Company, of Pall Mall-buildings, Chicago. A great deal of interest is being aroused in heating and cooking by these heaters in the same way that Messrs. Crompton are doing in England with the Carpenter heaters. The Ahearn electric stove is a very tasty adaptation, and will be sure to prove a useful piece of apparatus.

Utilising Water Power.—An eminent firm of engineers in Lancashire, we are told, are about to place before the public a new variety of methods of utilising water power. Instead of collecting the water of various streams into the reservoir, they seem to intend to use the power of each stream separately, and connect to a central station with accumulators. Except under very special circumstances we do not see great utility in the idea.

Electropathic Belts—We notice that the *British Medical Journal* is occupying its attention this week with reviews of two recently issued pamphlets by medical men on "electropathic" belts. The *Journal* questions the electrical knowledge of the authors, and entirely disagrees with the arguments, based upon a smattering of electrical know-

ledge, in which they claim efficacy for this apparatus in generating currents and, by implication, in curing disease.

Coast Communication.—Telephonic communication has now been established between the coastguard establishments at Margate, Ramsgate, and Deal, and preparations are being made for landing a cable from the East Goodwin lightship near Kingsdown and running a wire on to Dover. The disasters off this part of the coast have long rendered it most desirable that communication of the kind should be established, and its provision may result in the saving of many lives.

Laboratory.—At the meeting on the 9th inst. of the Société Internationale des Electriciens at Paris, M. Mascart gave an account of the efforts to establish an electrical laboratory for the society. The results have proved very satisfactory, the subscriptions having already amounted to 100,000 francs. MM. Weyher et Richemond have made a present to the society of a 25-h.p. engine, and M. A. Hillairet has undertaken to erect, free of cost, the whole of the mechanical part of the installation.

Telephone and Electric Waves.—M. Colson, in a note to the Académie des Sciences, deals with the use of the telephone in discovering electric waves, the method of which he had already communicated in a note (February, 1891) for an open circuit. He now studies this propagation in a closed circuit; he indicates the arrangement adopted and the results obtained. The telephone enables the interference to be clearly distinguished, and shows the influence of absorption and of the length of wave on this phenomenon.

Telephone Indicator.—An invention has been submitted to the French Minister of Commerce, to enable every subscriber to a telephone to know whether he has been called up in his absence, and by what subscriber. This is obtained by working the subscriber's call-bell in shunt off the central exchange battery. If the subscriber does not reply, the operator sends the whole current into the line, which actuates a Morse writer registering on a paper band the conventional signs designating the number of the subscriber who wished to speak.

Load Factor.—Various terms have been chosen by French electrical engineers to translate the term "load factor," invented by Mr. Crompton to express the important commercial relation, characteristic of a central station, between the electrical energy sold in a given time to that which the plant might be able to produce in the same time. The expressions *facteur de charge* or *coefficient de charge* have been proposed by M. Géraldy; but M. Hospitalier prefers *coefficient d'utilisation*, which seems sufficiently expressive and accurate, and will doubtless be adopted.

Wire-to-Wire Electric Communication.—Colonel J. R. Magrath, late assistant to the Director-General of Electric Telegraphs in India, writes as follows to the *Times* of Thursday: "Sir,—From the correspondence in the *Times*, it seems as if 'wire-to-wire electric communication' is looked upon as a new discovery. I beg to say that, before the mutiny in 1857, Sir William O'Shaughnessy, Director-General of Electric Telegraphs in India, made fairly successful experiments in this direction, which no doubt would have been continued and improved but for the mutiny needing our utmost efforts to keep the telegraph lines in working order."

Electrolytic Production of Chrome.—MM. Placet and Bonnet, says the *Bulletin Internationale*, obtain electrolytic deposits of chrome with a bath of 15 per cent. of sulphate of chrome slightly acidulated with sulphuric acid. Other baths are also used as follows: (1) Chrome alum 10 to 15 parts, sulphate of potash 10 to 15, oxalic acid 5, water 100 parts; (2) chromate of potash 10 to 15, chrome alum 15 to 20, water 100; (3) alum or fluosilicate of chrome 10 to 15, fluosilicate of ammonia 10 to 15, hydrofluoric acid 5 to 10, water 100 parts. Warm baths are preferable, and the same also for baths to which are added sugar, alcohol, or glycerine.

Aristol.—The chemical preparation known as aristol is the iodo-thymol prepared by making a solution of iodine in iodide of potassium act on a solution of thymol in caustic soda. The Farbenfabriken Company, of Elberfeld, states the *Revue de Chimie Industrielle*, has recently patented a process of electrolytic manufacture of this substance. A liquor is composed: of water 200, iodide of potassium seven, soda (in solution at 40deg. B.) 0.8, and thymol three parts. A current is passed through this liquid sufficient to give off six to eight centimetres of gas per minute. The aristol is formed at the positive pole; when the whole of the thymol is transformed the precipitate is collected, washed, and dried.

Train Lighting.—The makers of sets of train lighting plants, portable or otherwise, will have to keep their eyes open if they wish to show the railway companies what they can do. It is not every day that one can get managers of railway companies to look into schemes for better lighting, and the best time for mooting the subject is certainly when new enterprises are on hand. There are the new sleeping cars for the Compagnie Internationale des Wagons Lits—luxurious cars to take the traveller anywhere from Calais to St. Petersburg, in a miniature hotel. These are lighted by gas; they ought to be lighted by electricity. The company, no doubt, would if they could adopt the light. They should be shown the way.

Automatic Telephone Exchange.—An exchange for 80 subscribers, on the Strowger automatic system which we described recently, has been established at La Porte, near Chicago. It will be remembered that there are no telephone operators at all required on this system, each subscriber, by means of an ingenious piece of mechanism being able to switch himself on and off. The only attendant needed is a mechanic to keep the apparatus in repair. The exchange has already 24 subscribers, and a Press view, which created great interest, was recently held. The exchange works very satisfactorily. We ought to know something more about the system in this country, for if the practical difficulties do not prove too great, it might prove very remunerative for small exchanges.

Catalogue.—A handsome catalogue that has been forwarded to us for review is that of the Taunton dynamos from the Newton Electrical Engineering Works, of Taunton. An oil engine fitted with one of these dynamos on the same bed-plate is very useful for country mansions. A tramcar or launch motor of very compact type is illustrated, besides steam dynamos direct-coupled with engine and dynamo on the same bed-plate. Taunton dynamos of more than 100 amperes are fitted with Kapp's patent end connectors on the armature. We have already described the Newton-Hawkins brushholder and their automatic switch, their swinging switchboard and transformers. The firm are manufacturing good machines, and are rapidly taking a leading place as electrical engineers in the West of England.

Association of Central Station Engineers.—Central electric station engineers are, as a rule, the most modest of men. It is seldom we hear of their work, probably because they are so busy. But the time is rapidly approaching when there will be a really useful purpose served in occasional gatherings for the publication of methods and results and the exchange of ideas. The scheme has long been favoured in America, where annual

gatherings of those in command are held with good practical result. The difficulties are not so great in England for such a *réunion*, and one of the things most desired is full and carefully gathered up-to-date information of the practical nature that those in command of stations can give. There are now sufficient central stations at work, or being erected, for such a proposal to prove useful.

Council and Officers of the Institution.—The following is the proposed list of Council and officers of the Institution of Electrical Engineers, to be balloted for on Thursday, December 8: President, W. H. Preece, F.R.S. Vice-presidents (four to be elected): Alexander Siemens; R. E. Crompton, M.I.C.E.; Sir David Salomons, Bart., M.A.; Sir Henry Mance, C.I.E., M.I.C.E Ordinary members of Council: Major G. W. Addison, R.E.; Prof. J. A. Fleming, M.A., D.Sc.; Prof. George Forbes, F.R.SS. (L. and E.); Edward Hopkinson, M.A., D.Sc.; Colonel R. Raynsford Jackson; Prof. A. B. W. Kennedy, F.R.S., M.I.C.E.; W. M. Mordey; Prof. John Perry, D.Sc., F.R.S.; James Swinburne (remaining on Council); Frank Bailey; Walter T. Goolden, M.A.; Gisbert Kapp, M.I.C.E. Associate members of Council: W. A. Chamen; C. P. Sparks; Arthur Wright. Honorary treasurer: Sir David Salomons, Bart., M.A., vice-president.

Rome Exhibition.—After some little difficulties, which have now been satisfactorily surmounted, the project for holding in Rome in 1895-96 an International Exhibition of Fine Arts and Electricity, says the *Daily News*, is well under way. It is intended to solemnise the twenty-fifth anniversary of the annexation of Rome to the kingdom of Italy. Owing to the indifferent financial condition of the municipality, as well as to the fears which were entertained that the result would not have proved a successful one, subscriptions came in at first very slowly; but the idea of holding the exhibition gradually made progress, and the civic authorities have made over to the committee the grounds on which the exhibition buildings are to rise. This site is in the vicinity of "Ponte Milvio," about a mile's distance from "Porta del Popolo," in a very attractive position, bordering on the river, and commanding a fine view of the Sabine Hills.

Measurement of Magnetic Fields.—At the French Académié des Sciences on the 16th inst., M. Adolphe Berget read a paper on "The Measurement of Magnetic Fields." It is known that M. Fizeau employed the measure of the edges of thin plates to determine the value of the theoretical expansion of metals. M. Berget has had the idea of applying this delicate method of measurement to measure the expansion of iron in a magnetic field which can be varied in intensity. As soon as the current passes the edges are displaced, and take the normal position on breaking the current. The lengthenings have been thus measured of two ten-thousandths of a millimetre for a given intensity, and measured for intensities up to tenfold. The law of the variations of length is given by an exponiential formula. Neither Wertheim nor Wiedemann, who studied these delicate questions, ever thought that such small measurements could be made.

Increased Telephonic Charges.—At a meeting of the Executive Committee of the Hull Guardian Society held last week it was stated that the Government had taken over the trunk lines of the National Telephone and Western Counties Companies, and that notice had been received of their intention to raise the charge for a three minutes' conversation between town and town, from the present rate of 6d. to 1s. 6d. from January 1 next. The autumnal meeting of the Associated Chambers of Commerce had already passed a resolution in opposition to the proposed increase, and it was stated that this step had been resolved upon to enable the Government to make up for the falling revenue of the Telegraphic Department. The members of the Hull society were of opinion that the enhanced rate would block the present easy facilities for commercial conversation; but it was decided to await further information before taking any definite steps to join a deputation to the Postmaster-General.

An Electrical Detective.—Boot dealers in Paris, says the *Shoe and Leather Record*, who expose their goods outside their shops appear to be liable to the same kind of depredations as with us. Recently a retailer in that city who had for some time past been subject to so many mysterious pilferings that his losses became serious, hit upon an ingenious application of electricity for the detection of the thief. He so arranged his goods at the more exposed corners that certain pairs were placed in connection with the wire of an electric bell. One morning as he was sitting at breakfast he heard the bell ring suddenly, and, hurrying out, saw a young man running away at full speed. But the shoemaker was a better runner than the thief, whom he overtook and secured. The prisoner told the old story that he was only examining the goods with a view to buying them. But it happened that upon being searched he was found to have only four sous in his possession, and the Commissary of Police naturally declined to accept the explanation.

Electricity in Mining.—Prof. Robinson delivered a lecture on Saturday afternoon in the large theatre of Nottingham University College on "Electricity, as Applied to Mining." The lecture was one of a series arranged by the midland counties branches of the National Association of Colliery Managers, in conjunction with the Technical Education Committee of the Notts. and Derbyshire County Council, for the benefit of mining engineers, colliery managers, deputies, and others. Prof. Robinson, in his opening remarks, said that, for practical mining, the uses of electricity were daily increasing, and it was becoming a more and more useful agent in the coal mine. A number of experiments were given illustrating the usefulness of electricity in mines, and the speaker dealt with the general application of electric power in mines, for lighting, pumping, and hauling, economy in the transmission and distribution of electric power, the measurement of power, and the advantages of electric plant. The lecturer received a hearty vote of thanks.

Obituary.—The death is recorded of Prof. Chas. A. Seeley, for many years a member of the editorial staff of the *Scientific American*, and one of the founders of the American Electric Light Company. In the early days of dynamo design, Dr. Seeley devoted much attention to obviating the loss of energy in the iron core of the armature. He enunciated the theory that the loss resulted from a twofold cause: the so-called Foucault currents, and a second cause then unrecognised, but since named hysteresis by Prof. Ewing. His theories are now generally adopted, and due credit should be given to this investigator. His theories resulted in the design of a coreless disc armature, which was exhibited at the first Paris Exhibition, and again at the Crystal Palace Exhibition of 1882, where the exhibitors received a gold medal. He was a member of the American Association for the Advancement of Science, and of the American Institute. His scientific knowledge was very wide, embracing, besides electricity, chemistry, in which he was an expert.

Technical Education. — The address by Mr. Llewellyn Smith before the London Chamber of Commerce on Wednesday, went to show very forcibly what large strides are being taken all over the country in the

matter of technical education. The one lagger behind was London, and it is probable that the London County Council itself may soon be in the van of progress. The time lost in waiting may not be entirely wasted, and we may see a scheme for London eventually carried that will redound to its credit. It is to be hoped that everyone with any influence, or means for making the scheme perfect at their disposal, will aid in every way the project for the establishment of real technical and commercial education for London. There should be no longer, on the one hand, a mere tinkering on the outskirts of technical training, and on the other, no losing the way in the slough of despond under South Kensington rule, but a well-considered scheme which will serve to put England, and especially London, in the front rank in this direction. The time for organising is now with us. In a few years it may be too late to reconsider the question.

Guttapercha.—M. Leon Brasse (in *Electricité*) has a study on the production of guttapercha. He comes to the conclusion that all guttas of superior quality have a weak specific resistance, and it is not at all demonstrated that they are the product of trees of the genus Dichopsis; that the gutta from Pahang, the product of the Dichopsis oblongifolium, is a guttapercha of average quality—its specific resistance being sufficiently high; the bolungan and coti guttas used in the past have a low specific resistance, those we are now using have one which gets higher and higher, and it is necessary to be very careful in their use; the white guttas all present a high specific resistance, they cannot be employed alone, nor in large proportion, for the manufacture of cables; lastly, he does not think that it should be the product of a Dichopsis which, as maintained, has been exclusively used as dielectric for submarine cables, as its resistance always rises to about 400 × 10^6 megohms, and he does not know a cable of English manufacture whose specific resistance exceeds 120 × 10^6 megohms. The best qualities, M. Brasse thinks, are those of Pahang, Sarawak, and Sandakan. It would seem well, before adopting and planting a Dichopsis gutta or oblongifolium, whose output is so small, to make search near Pahang and the north of Borneo and verify the assertions of M. Leys relative to these latter regions. The importance of the capital which it is necessary to sink in plantations for some years necessitates absolute surety of the result to be achieved.

Ward Leonard System.—Mr. H. Ward Leonard's system of double generator motor driving for electric cars was severely criticised by Dr. Hutchinson at the discussion of the railway papers, at the American Institute of Electrical Engineers, principally on account of cost. The combined efficiency of the Leonard system, claimed for 54 per cent., would, he maintained, come to only 37·6 per cent., or with field losses 33 per cent., as against 27 per cent. with commutated fields, a saving hardly worth the complication. As regards power at the power-house, Mr. Leonard's proposition of 6 h.p. steady demand per car he thought would not be enough; the idea of going only three miles an hour uphill would not meet the wishes of managers. Many plants were being put in now with 60 h.p. per car, as it was found fully 40 h.p. was required going uphill at speed. The cost he also makes double Mr. Leonard's figures, and points out that the extra weight would also necessitate the consumption of more power. Mr. Ward Leonard, replying to this, said, with regard to efficiency, accurate tests had been taken by William Sellers and Co., of Philadelphia, and the efficiencies claimed have been well borne out. With regard to power, he did not maintain that 6 h.p. would be sufficient for a car, but that 6 h.p. per car would be an average figure, some taking more and some less. It was evident if large changes of load could be avoided the cost of power plant would be less; in fact, his experience on cranes and elevators lead him to believe it would be just half. The cost of motors is not so important as would at first seem. In a plant he was designing they came to 5 per cent. of the whole cost. If they amounted to even 10 per cent. of the whole, with advantage of using engines at full load, it would still pay to use his method. With reference to depreciation, he found in practice the machinery on the system requires very little attention. There is only one lever to accomplish all changes of speed. The electric brake used returns energy to the line while stopping the car. The use of secondary line enables engineers, if desired, to use 1,000 volts in the trolley line while sending only 300 or 500 volts into the propelling motors. The principal point is the flattening of the load diagram, which means the halving of the cost of engines and dynamos, and a very great increase in efficiency, both in the engines and by the energy returned to the line. The system is to be tried shortly on a street-car line.

Balancing Armature Reactions.—To lead the armature current by special wires through slots on the surface of the pole-pieces is the method which is being investigated by Harris J. Ryan (*Sibley Journal of Engineering*, reproduced in *Electrical World*, November 19th), for obviating the magnetising effects of the armature currents in the magnetic field. Mr. Ryan, in conjunction with Mr. M. E. Thompson, has made six machines with slotted pole pieces, two of which have been tried, and other results are to be published. The details of the second machine are thus given: output, 40 amperes, 100 volts at 1,200 revolutions; type four-pole, field of cast iron in two pieces, armature, drum winding through 58 grooves, five No. 10 B. & S. wires each groove, winding in two circuits, 29 commutator bars; grooves, ⅝in. by $\frac{3}{32}$in., outside diameter of core 7⅛in., inside 3in., built of discs, length of armature and poles, 6in. each. Effective length of iron in armature core, 5in. Magnetic leakage 1[illegible] per cent. Field cores, 5in. by 2in., rounded ends, area, 9·14 square inches. Mean length of field, magnetic circuit, 12·5in. Magnetic density in armature core, 5,400; in air gap, 4,900; in armature lugs, 8,400; in field cores, 6,[illegible]. Field winding—mean length of turn, 15in. Requisite exciting E.M.F. for field, 910 ampere-turns; armature, 25 ampere-turns; air gap, 1,000 ampere-turns—or a total of 1,935 ampere-turns. Requisite size of wire for excitation at 100 volts, 1,575 circular mils; size adopted, No. 1[illegible] B. & S.—of this enough was wound to bring exciting current density down to 1,000 circular mils per ampere. Weight of completed machine, 400lb. The number of special balancing conductors in each pole face is given by the following proportion: The product of the armature conductors under a pole into the current in the same is equal to the product of the balancing conductors back of each pole face in the current (total armature current) through them. It will be seen no regard is made for the pernicious effects usually present with so short an air gap with so large a number of ampere-turns. No such effects were observed in this machine. The machine could be loaded to 100 amperes with no fall of potential at brushes, except that due to ohmic resistance—there was no shifting of the neutral point. All cross induction may be avoided or even reversed in its effects. The output for given weight may be largely increased over that realised in the common practice of to-day. The air gap may be made as small as mechanical requirements permit, thus enabling one to realise the advantages of differential excitation so successfully utilised in the modern alternate-current transformer.

OUR PORTRAITS.

Volk, Magnus, A.I.E.E. Born at Brighton in 1851. From his earliest days he was interested in electrical and general engineering work. Owing to the death of his father (a clever mechanician) he was thrown upon his own resources at an early age. His first commercial venture was the introduction of a model telegraph instrument, of which about 60,000 were sold in a short time. He was then employed by Captain Harvey, who was then developing his "towing torpedo." This led to his introduction to Messrs. Vavasseur and Co., for whom, under Captain McEvoy, he constructed and devised considerable quantities of torpedo apparatus. The converting of the Martini Henry rifle into a magazine gun was then taken in hand, and, when nearly completed, a sudden and nearly fatal illness in 1891 caused the loss of the business, and necessitated a fresh start. This occurred in connection with the United Telephone Company, who placed the opening up of Brighton and the surrounding district complete with telephone exchanges in his hands. This was successfully accomplished and Brighton connected with London by a trunk wire; he also designed complete exchange switchboards and various switches and bells for subscribers' use. The lighting up of his factory and private house by electricity led to his obtaining the order to light the Royal Pavilion, Brighton, for the Corporation, with an installation of 1,100 lamps, probably the largest installation in the country at that date—April, 1883. The electric transmission of power was next experimented with on a strip of ground under the sea-wall at Brighton, a small electric railway being constructed and worked, it being the first public electric conveyance opened in this country – August, 1883. This proving very successful, application was made to the Corporation for extension and reconstruction on a larger scale. This was carried out amid a perfect storm of opposition from cabmen and others prejudiced against any innovation. These obstacles were, however, overcome, and although repeatedly damaged by gales, has continued running successfully till the present time. It is now being converted to the third-rail system, and new rolling-stock is being constructed. He has been and is a contributor of various articles to the technical journals. Mr. Volk is now taking Mr. H. Hewett and his son as partners—the firm being under the style of Hewett, Volk, and Hewett, the object being to obtain statutory powers and construct and work electric railways, etc.

Capito, Chas., M.Inst.Mech.E., M.Inst.Elec.E., was born and educated in Copenhagen. He served his apprenticeship as a mechanical engineer and studied for several years at the technical college in his native town, out of which he passed with honours. Mr. Capito was for some time consulting engineer to the Cryolite Mining Company, of Copenhagen, and spent a year at this company's mines in Greenland, where he was occupied in making a survey of the mining district, and also in the construction of new machinery. In 1880 Mr. Capito came to England, and was soon after appointed assistant to Prof. W. E. Ayrton, F.R.S., at the City and Guilds of London Institute. No doubt many of our readers will remember Mr. Capito from the time when they attended the course of electrical engineering at the Cowper-street School. In 1882 Mr. Capito accepted the appointment as chief electrical engineer to the Electrical Power Storage Company, Limited. He was the technical representative of this company in New York, Vienna, and Berlin. Subsequently Mr. Capito joined the well-known School of Electrical Engineering, then under the management of the late Mr. Lant Carpenter, and has thus had a very prominent position in the training of the younger generation of electrical engineers, upon whose work the success of the industry to a great extent depends. Mr. Capito has for some years been established as a consulting engineer.

Joel, Henry Francis, commenced his career as an architect. At the age of 14 he was articled as a pupil to Mr. J. Tanner, F.R.I.B.A., with whom he served three years—from 1865 to 1868. He then entered into the engineering profession as assistant to Mr. Robert Sabine, C.E. and electrician, and also became a seven years' student in the Institution of Civil Engineers, during which time he obtained a Miller prize. As assistant to Mr. R. Sabine and Mr. Latimer Clark, he carried out the work of laying the Pneumatic Despatch Railway in London, as well as the electrical testing of several submarine telegraph cables. Mr. Joel first became connected with electric lighting in the year 1870, when he was assistant to the late Sir Charles Wheatstone, F.R.S., at his electric telegraph factory, where electric light apparatus and Gramme dynamo machines were made. During this period Mr. Joel assisted to fit up the 20,000-arc lamp tried on the clock tower of the House of Commons. He remained with Sir Charles Wheatstone until 1873. In 1873 and 1874 he took charge, for Sir Samuel Canning and Mr. Sabine, of the electrical testing, and served as electrician during the laying in the West Indies of a submarine telegraph cable of 740 knots in length. In 1877 he was elected an associate of the Institution of Civil Engineers. In 1878 Mr. Joel entered into partnership in a signal engineering business with Messrs. Latimer Clark, Muirhead, and Co., of Westminster, and whilst conducting that business became acquainted with Mr. Werdermann. Mr. Joel suggested and made various important improvements in the Werdermann lamp, and brought that lamp prominently into notice. He invented and patented his own semi-incandescent lamp, amongst many other inventions, in 1879, and has since that year been exclusively engaged in electric lighting, fitting up installations and perfecting a dynamo machine with detachable coils on the armature, and other improvements. Mr. Joel's lamps were exhibited in practical action at the Paris Electrical Exhibition of 1881, where they were awarded a silver medal. In the Crystal Palace Electrical Exhibition of 1882, the Joel lamps were shown in the Pompeian Court, and were awarded a gold medal. In May, 1882, the Pilsen-Joel Electric Light Company was brought out. Mr. Joel held the position of managing engineer to that company, and planned their very large factories in Kentish Town. Mr. Joel resigned his position with the company in September, 1883, and started in business for himself as an electric light engineer. As electrical engineer to the Leeds Corporation he supervised the electric lighting of the municipal buildings at Leeds, as well as other electric light installations. Mr. Joel is now carrying on a business as electrical engineer in Wilson street, Finsbury, E.C., and has patented many interesting inventions—amongst others, a meter for electric light, a new motor with laminated fields and armature, and a special arrangement of the fields for alternating-current circuits.

Newton, Francis Murray. Born 1852, at Barton Grange, Taunton. Educated at Eton and Oxford, of which university he is a graduate. Whilst studying physical science under Prof. Pritchard and Prof. Clifton, he was selected as one of the observers on the Government expedition in 1874 to observe the transit of Venus across the sun at "Station A," near Cairo. Whilst there, in addition to the ordinary work of an observer, he was responsible for the care of all the clocks and chronometers on which the accuracy of all the results to be obtained depended, for the meteorological instruments and observations, and also had general charge of the telegraphic instruments and their operation, by means of which signals were transmitted between Greenwich Observatory and "Station A," and the exact longitude of the latter determined. In consideration of these services he was elected a Fellow of the Royal Astronomical Society. After serving an apprenticeship to Messrs. Easton and Anderson, Erith, he was elected an associate of the Institute of Civil Engineers, and appointed Instructor in Practical Mechanics at Eton College, which post he held for two years. He then devoted himself entirely to electrical work, although he had made his first dynamo in 1879, and having patented several modifications of dynamos and arc lamps, he went, in 1881, for a short time to Messrs. Woodhouse and Rawson, and was afterwards appointed manager of the Belfast Electrical Appliances Company, Limited, where he brought out the well-known Belfast arc lamp, and a good practical form of open-coil dynamo, many of which are doing good work at the present day, and obtained for his firm the bronze medal at the Cork Electrical Exhibition. Resigning this appointment,

he started a business on his own account at Taunton, devoting himself chiefly to the improvement and manufacture of the dynamo; here he has from time to time built new works, and is at present proprietor of the Newton Electrical Engineering Works adjoining the G.W.R. Station.

Offer, George. Born in London in 1827. It was not till the year 1878 that Mr. Offer turned his attention more directly to electrical matters, and became the English agent for Schuckert. The following year he became connected with the Anglo American, which has subsequently developed into the Brush, and was for a time busily engaged in installation work and in the negotiations for concessions, becoming general manager of the subsidiary South Eastern Brush in 1882, but in 1883, on the formation of the Consolidated, Mr Offer undertook the management of this company, and under this management the B.T.K. system was tried at Colchester. Mr. Offer was one of Lord Thurlow's committee for obtaining an amendment of the Electric Lighting Act of 1882. Under the auspices of the Electric Installation Company, and Mr. Offer's management (although the concerns are now separate companies), the Sydenham hill central station was built and the Crystal Palace District Company formed. Similar work was done at Oxford. Both these stations have been described in our columns, and we understand that the Oxford installation especially is making good headway. It will be seen that Mr Offer has imparted a vast amount of energy into his electrical work, and it is to be hoped the results will be commensurate with the energy displayed.

ON THE ATTRACTION OF INFINITE ELLIPTIC CYLINDERS.*

BY GEORGE A. GIBSON, M.A.

The expressions for the attraction of infinite elliptic cylinders are usually deduced from the formulas for the attraction of ellipsoids. In this paper I propose to consider the attraction of cylinders without reference to the more general case of ellipsoids; the solutions I give follow immediately from the values of certain integrals which I have given in a paper in the tenth volume of the *Proceedings* of the Edinburgh Mathematical Society.

1. The attraction of a thin rod, infinitely extended in both directions, and of mass k per unit of length is $2k/r$, r being the distance of the attracted point from the rod. Now, suppose we have a cylinder infinitely extended in both directions, and we take as axis of z a line parallel to the generators of the cylinder. The resultant attraction at any point will be in a plane perpendicular to the generators; this plane will be taken as that of xy. Let (x, y) be the co-ordinates of the attracted point, (x', y') those of a point in the section of the cylinder made by the plane of xy, dS a small area round (x', y'), $\rho\, dS$ the mass per unit length of the thin cylinder, having dS for section, and having its generators parallel to the axis of z, and r the distance between (x, y) and (x', y'). The components of the attraction towards the origin will be given by

$$X = 2\int \frac{x - x'}{r^2}\,\rho\, dS\,;\; Y = 2\int \frac{y - y'}{r^2}\,\rho\, dS\,,$$

where the integrations extend over the section of the cylinder made by the plane of xy. If we put $V = 2U = 2\int \log \frac{1}{r}\,.\,\rho\, dS$, we get $X = -2\frac{dU}{dx}$, $Y = -2\frac{dU}{dy}$.

The function U is generally called the logarithmic potential. Like the ordinary potential, it satisfies Poisson's equation (with $2\pi\rho$ instead of $4\pi\rho$, since $U = \frac{1}{2}V$), but it does not vanish for $r = \infty$. If R be the distance of (x, y) from a fixed point at a finite distance from the origin, the limit when R is infinite of $U \div \log\frac{1}{R}$ is equal to $\int \rho\, dS$, that is, to the quantity of matter in unit length of the cylinder. Further, U and its first differential coefficients are finite and continuous.

The most convenient co-ordinates for present purposes are the parameters of the confocal ellipses and hyperbolas passing through a point, and throughout the paper I use the following notation—$2c$ is the distance between the foci of the section of the cylinder, supposed to be elliptic

$$x' = c\cosh u \cos\theta \qquad x = c\cosh v\cos\phi$$
$$y' = c\sinh u\sin\theta \qquad y = c\sinh v\sin\phi$$
$$dS = \tfrac{1}{2}c^2(\cosh 2u - \cos 2\theta)\,du\,d\theta.$$

Any ellipse will be determined by the parameter u. When the section is bounded by two confocal ellipses, λ and μ will be taken for the parameters of the outer and of the inner respectively, and the semi-axes will be given by $a = c\cosh\lambda$, $b = c\sinh\lambda$, $a' = c\cosh\mu$, $b' = c\sinh\mu$. The values $\alpha = c\cosh v$, $\beta = c\sinh v$ will also be used, so that $x = \alpha\cos\phi$, $y = \beta\sin\phi$.

An arc of the ellipse v = constant, and of the hyperbola ϕ = constant, will be given by $J\,ds_1 = d\phi$, $J\,ds_2 = dv$, where

$$1/J^2 = \tfrac{1}{2}c^2(\cosh 2v - \cos 2\phi).$$

Usually, it will be considered sufficient to determine U, as the attractions can be found from that by differentiation. The integrations that occur follow so directly from the formulas of the paper referred to above, that I have thought it unnecessary to reproduce them.

2. The section bounded by two confocal ellipses λ, μ $(\lambda > \mu)$, and ρ constant.

(i.) The attracted point, P (x, y) or (v, ϕ), outside the area, so that $v > \lambda$.

$$-2U = \pi\rho c^2(\sinh 2\lambda - \sinh 2\mu)\left(\log\frac{c}{2} + v + \tfrac{1}{2}e^{-2v}\cos 2\phi\right)$$
$$= \pi\rho c^2(\sinh 2\lambda - \sinh 2\mu)\left(\log\frac{\alpha + \beta}{2} + \tfrac{1}{2}e^{-2v}\cos 2\phi\right)$$

since $v = \log e^v = \log(\cosh v + \sinh v)$; and, therefore

$$\log\frac{c}{2} + v = \log\frac{\alpha + \beta}{2}.$$

If A be the area of the section, $A = \frac{1}{2}\pi c^2(\sinh 2\lambda - \sinh 2\mu)$;

$$\therefore\ U = \rho A\log\frac{2}{\alpha + \beta} - \tfrac{1}{2}\rho A e^{-2v}\cos 2\phi$$

In this case λ and μ occur only in the factor A, so that U, and therefore the attraction, is the same whenever the area of the section (bounded by two confocals) is the same.

(ii.) The attracted point, P, in the hollow so that $v < \mu$.

$$-2U = \pi\rho c^2(\sinh 2\lambda - \sinh 2\mu)\log\frac{c}{2} + \pi\rho c^2(\lambda\sinh 2\lambda - \mu\sinh 2\mu)$$
$$-\tfrac{1}{2}\pi\rho c^2(\cosh 2\lambda - \cosh 2\mu) - \tfrac{1}{2}\pi\rho c^2(e^{-2\lambda} - e^{-2\mu})\cosh 2v\cos 2\phi$$

If this be expressed in terms of the axes and of x, y, we get

$$U = \pi\rho ab\log\frac{2}{a + b} - \pi\rho a'b'\log\frac{2}{a' + b'} + \tfrac{1}{2}\pi\rho(ab - a'b')$$
$$+\tfrac{1}{2}\pi\rho\left(\frac{a - b}{a + b} - \frac{a' - b'}{a' + b'}\right)(x^2 - y^2).$$

(iii.) P in the attracting mass, so that $\lambda > v > \mu$.

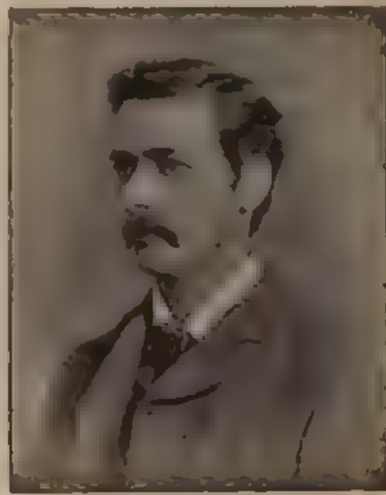
$$-2U = \pi\rho c^2\{\lambda\sinh 2\lambda + (\sinh 2\lambda - \sinh 2\mu)\log\frac{c}{2} - \tfrac{1}{2}\cosh 2\lambda\}$$
$$-\tfrac{1}{2}\pi\rho c^2 e^{-2\lambda}\cosh 2v\cos 2\phi - \pi\rho c^2\sinh 2\mu\,(v - \tfrac{1}{2}e^{-2v}\cos 2\phi)$$
$$+\tfrac{1}{2}\pi\rho c^2(\cosh 2v + \cos 2\phi);$$

or,

$$U = \tfrac{1}{2}\pi\rho(a^2 + b^2) + \pi\rho ab\log\frac{2}{a + b} - \pi\rho a'b'\log\frac{2}{\alpha + \beta} + \tfrac{1}{2}\pi\rho a'b' e^{-2v}\cos 2\phi$$
$$+\tfrac{1}{2}\pi\rho(a - b)^2\cosh 2v\cos 2\phi - \tfrac{1}{2}\pi\rho c^2(\cosh 2v + \cos 2\phi)$$

* Paper read before the Physical Society of Glasgow University.

F. M. NEWTON.



HENRY F. JOEL.

MAGNUS VOLK.

GEORGE OFFER.

CHARLES CAPITO.

If the cylinders be circular, the expressions for U are easily deduced from the above. If D be the distance of P from the axis, they are as follows:

(i.) $U = \rho A \log \frac{1}{D}$.

(ii.) $U = \pi \rho a^2 \log \frac{1}{a} - \pi \rho a'^2 \log \frac{1}{a'} + \frac{1}{2} \pi \rho (a^2 - a'^2)$ = constant.

(iii.) $U = \pi \rho a^2 \log \frac{1}{a} - \pi \rho a'^2 \log \frac{1}{D} + \frac{1}{2} \pi \rho (a^2 - D^2)$;

since $b = a$, $b' = a'$, $\beta = \alpha = D$.

3. To find the components of the attraction in the cases just considered.

If N and T be the normal and tangential components respectively, $N = -2 J dU/dv$, $T = -2 J dU/d\phi$, and the resultant $R = \sqrt{N^2 + T^2}$. If the components parallel to the axes be wanted, then denoting by n the angle which the normal to the ellipse v at the point ϕ makes with the axis of x.

$$X = N \cos n - T \sin n, \quad Y = N \sin n + T \cos n,$$

where $\cos n = J c \sinh v \cos \phi$, $\sin n = J c \cosh v \sin \phi$.

After some reductions we get the following values:

(i.) $v > \lambda$.

$$X = \frac{4 \rho A}{c} e^{-v} \cos \phi, \quad Y = \frac{4 \rho A}{c} e^{-v} \sin \phi,$$

$$R = \frac{4 \rho A}{c} e^{-v}.$$

Hence R is the same for all points on the ellipse v, and its direction makes with the axis of x an angle ϕ.

(ii.) $v < \mu$.

$$X = -2 \frac{dU}{dx} = -2 \pi \rho \left(\frac{a-b}{a+b} - \frac{a'-b'}{a'+b'} \right) x.$$

$$Y = -2 \frac{dU}{dy} = 2 \pi \rho \left(\frac{a-b}{a+b} - \frac{a'-b'}{a'+b'} \right) y.$$

$$R = 2 \pi \rho \left(\frac{a-b}{a+b} - \frac{a'-b'}{a'+b'} \right) \sqrt{x^2 + y^2},$$

and the direction of R makes with the axis of x the angle $\tan^{-1}(-y/x)$.

(iii.) $\lambda > v > \mu$.

$$X = 2 \pi \rho c \left\{ \left(1 - e^{-2\lambda} \right) \cosh v - e^{-v} \sinh 2\mu \right\} \cos \phi.$$

$$Y = 2 \pi \rho c \left\{ \left(1 + e^{-2\lambda} \right) \sinh v - e^{-v} \sinh 2\mu \right\} \sin \phi.$$

The value of R in this case is somewhat complicated, but if $\mu = 0$

$$X = 2 \pi \rho \left(1 - e^{-2\lambda} \right) x = 4 \pi \rho \frac{b}{a+b} x$$

$$Y = 2 \pi \rho \left(1 + e^{-2\lambda} \right) y = 4 \pi \rho \frac{a}{a+b} y.$$

$$R = 4 \pi \rho \frac{ab}{a+b} \sqrt{\left(\frac{x^2}{a^2} + \frac{y^2}{b^2} \right)}.$$

Hence R is the same for all points on any ellipse which is similar to the boundary of the section.

4. In general U is given by

$$-2U = \tfrac{1}{2} c^2 \iint \log r^2 . (\cosh 2u - \cos 2\theta) \rho \, du \, d\theta.$$

If $\rho (\cosh 2u - \cos 2\theta)$ = constant = k, suppose, then we get

(i.) $\lambda < v$, or P outside the cylinder,

$$U = \pi k c^2 (\lambda - \mu) \log \frac{2}{\alpha + \beta}.$$

But if M be the quantity of matter in unit length of the cylinder, $M = \pi k c^2 (\lambda - \mu)$. Hence $U = M \log \frac{2}{\alpha + \beta}$, and the equipotential surfaces are confocal cylinders.

(ii.) P in the space surrounded by the matter—that is, $v < \mu$.

$$U = \tfrac{1}{2} M \left(\log \frac{2}{a+b} + \log \frac{2}{a'+b'} \right)$$
= constant.

(iii.) P in the attracting matter—that is, $\lambda > v > \mu$.

If M_1 be the quantity of matter between the cylinders μ and v, M_2 that between v and λ, so that $M_1 + M_2 = M$, then

$$U = M_1 \log \frac{2}{\alpha+\beta} + \tfrac{1}{2} M_2 \left\{ \log \frac{2}{\alpha+\beta} + \log \frac{2}{a+b} \right\}$$

$$= \pi k c^2 (v - \mu) \log \frac{2}{\alpha+\beta} + \tfrac{1}{2} \pi k c^2 (\lambda - v) \left\{ \log \frac{2}{\alpha+\beta} + \log \frac{2}{a+b} \right\}.$$

As in case (i.), the equipotential surfaces are confocal cylinders.

If p be the perpendicular from the centre of the ellipse, u, on the tangent at the point θ, then $(\cosh 2u - \cos 2\theta) p^2 = 2 c^2 \cosh^2 u \sinh^2 u$, and therefore $\rho = k p^2 / 2 c^2 \cosh^2 u \sinh^2 u$.

More generally if $\rho = p^2 . f(u)$, where $f(u)$ is a function of u only, it is clear that the equipotential surfaces will be confocal cylinders when the attracted point is outside or in the matter of the attracting cylinder, and U will be constant when the point is in the space surrounded by the matter.

5. If ρ be a function of u only—that is, if the matter be arranged in confocal layers—the discussion is simple.

$$-2U = \tfrac{1}{2} c^2 \int_\mu^\lambda f(u) du \int_0^{2\pi} \log r^2 (\cosh 2u - \cos 2\theta) \, d\theta.$$

Hence

(i.) $v > \lambda$.

$$-2U = 2\pi c^2 \left(v + \log \frac{c}{2} \right) \int_\mu^\lambda f(u) \cosh 2u \, du$$
$$+ \pi c^2 e^{-2v} \cos 2\phi \int_\mu^\lambda f(u) \cosh 2u \, du;$$

or, $$U = M \log \frac{2}{\alpha + \beta} - \tfrac{1}{2} M e^{-2v} \cos 2\phi;$$

so that when $v > \lambda$, U is of same form as when ρ is constant.

(ii.) $v < \mu$.

$-2U = 2\pi c^2 \int_\mu^\lambda \left(u + \log \frac{c}{2} \right) f(u) \cosh 2u \, du + \pi c^2 \cosh 2v \cos 2\phi \int_\mu^\lambda e^{-2u} f(u) \, du$ so that U has the form $C + D \cosh 2v \cos 2\phi$, or $C^1 + D^1 (x^2 - y^2)$ where C, D, C^1, D^1 are independent of v, ϕ or x, y—the same form as when ρ is constant.

(iii.) $\lambda > v > \mu$.

$-2U = 2\pi c^2 (v + \log \frac{c}{2} + \tfrac{1}{2} e^{-2v} \cos 2\phi) \int_\mu^v f(u) \cosh 2u \, du + 2\pi c^2 \int_v^\lambda \left(u + \log \frac{c}{2} \right) f(u) \cosh 2u \, du + \pi c^2 \cosh 2v \cos 2\phi \int_v^\lambda e^{-2u} f(u) \, du.$

In case (i.) the attractions are $X = \frac{4M}{c} e^{-v} \cos \phi$, $Y = \frac{4M}{c} e^{-v} \sin \phi$.

In case (ii.) the attractions are $X = 2 D' x$, $Y = -2 D' y$.

6. In the general case when ρ is a function of u and θ, we suppose the function F (u, θ) expanded in a series of sines and cosines of multiples of θ, the coefficients being functions of u. Then since

$$\int_0^{2\pi} \log r^2 . {\sin \atop \cos} m\theta . d\theta = -\frac{4\pi}{m} {\sin \atop \cos} m\phi . {\sinh \atop \cosh} m v . e^{-mu} \quad u > v$$

$$= -\frac{4\pi}{m} {\sin \atop \cos} m\phi \, {\sinh \atop \cosh} m u e^{-mv} \quad u < v$$

the value of the potential can be expressed in a series involving integrals with respect to u only.

If $\rho = \Sigma\, A_n \cos n\,\theta + \Sigma\, B_n \sin n\,\theta$, then it is easily seen by considering the integral which defines U or otherwise, that

$$U = C_o \log \frac{2}{a+\beta} + \sum_{n=1}^{\infty} e^{-nv}(C_n \cos n\phi + D_n \sin n\phi)\, v > \lambda$$

$$U = E_o + \sum_{n=1}^{\infty} (E_n \cosh n\,v \cos n\,\phi + F_n \sinh n\,v \sin n\,\phi)\, v < \mu$$

If $\lambda > v > \mu$, U will be given by integrals which have v as one of the limits, since in that case

$$\int_\mu^\lambda f(u)\,du \int_0^{2\pi} \log r^2 . \cos n\,\theta\, d\theta = \int_\mu^v f(u)du \int_0^{2\pi} \log r^2 . \cos n\,\theta\, d\,\theta$$
$$+ \int_v^\lambda f(u)du \int_0^{2\pi} \log r^2 \cos n\theta d\,\theta,$$

and the integral with respect to θ has a different value in the two cases.

In special cases the complete solution is easily found; for example, when $\rho = Ax + By + C$, or $Ax^2 + Bxy + Cy^2 + D$, and so on; or when $\rho = k\,.f^{2n}$, where f is the distance of (u, θ) from the origin, since $f^2 = \frac{1}{2}\, c^2 (\cosh 2\, u + \cos\, 2\,\theta)$.

7. If the inner boundary of the cylinder is a similar and coaxal ellipse, the integrals are usually more complicated than when it is a confocal ellipse. We may now put $x' = m\, a \cos\,\theta$, $y' = m\, b \sin\,\theta$, and the outer boundary will be determined by $m = 1$, the inner by $m = m' = a'/a = b'/b$.

$$-2\,U = a\,b \int_{m'}^1 m\,d\,m \int_0^{2\pi} \log\{(x - m\,a\cos\,\theta)^2 + (y - m\,b \sin\,\theta)^2\}\,\rho\, d\,\theta.$$

If (x, y) be in the space surrounded by the matter, and if ρ be constant, we have, since the integral with respect to θ is $4\,\pi \log \frac{m\,a + m\,b}{2}$,

$$U = \pi\,\rho\, a\, b \log \frac{2}{a+b} - \pi\,\rho\, a'\, b' \log \frac{2}{a'+b'} + \tfrac{1}{2}\,\pi\,\rho(ab - a'\,b') = \text{constant.}$$

In this case, therefore, the attraction is zero.

If (x, y) be outside, and if we suppose the shell to be infinitely thin, we find

$$U = 2\,\pi\,\rho\, a\, b\, m\; d\,m\; \log \frac{2}{a+\beta} = M \;\log \frac{2}{a+\beta};$$

where M is the mass of unit length of the shell, and a, β the semi-axes of the confocal through (x, y).

The integration with respect to m for a cylinder of finite thickness, though quite easy, is rather complicated in its final expression; but if we suppose $m' = 0$ so that the cylinder is complete, we get as in §1

$$U = \pi\,\rho\, a\, b \log \frac{2}{a+\beta} - \tfrac{1}{2}\,\pi\,\rho\, a\, b\, e^{-2v} \cos 2\,\phi.$$

In the case where m' is not zero the expression involves also confocals with respect to the inner boundary.

If ρ is not constant the integrations are usually complicated, but it is obvious that if the matter be arranged in strata bounded by similar elliptic cylinders there will be no attraction at an internal point though the density be different in different strata. These conclusions are easily deduced by the usual geometrical method.

8. In dealing with surface distributions on an elliptic cylinder it is, perhaps, simplest to write $d\,s = J^{-1} . d\,\theta = (a\,b/p)\, d\,\theta$, where $d\,s$ is an elementary arc of the ellipse λ, and p is the perpendicular on the tangent at θ. If σ be the surface density, then

$$-2\,U = a\,b \int_0^{2\pi} \frac{\sigma}{p} \log r^2 . d\,\theta.$$

If $\sigma = k\,p$, then the mass on unit length of the cylinder is M where $M = 2\,\pi\, a\, b\, k$. Hence

$$U = M \log \frac{2}{a+\beta}\; v > \lambda.$$

$$U = M \log \frac{2}{a+b}\; v < \lambda.$$

It may be noticed that since $\sigma = M\; p/2\,\pi\, a\, b$, we get, when we express σ in terms of λ and θ,

$$\sigma = \frac{M}{2\,\pi\, c}\left(\frac{2}{\cosh 2\,\lambda - \cos 2\,\theta}\right)^{\frac{1}{2}}.$$

Hence, if $\lambda = 0$—that is, if the cylinder becomes a plane of breadth, $2\,c$,

$$\sigma = \frac{M}{2\,\pi\, c \sin\,\theta} = \frac{M}{2\,\pi\, \sqrt{c^2 - x^2}}.$$

The potential is, of course, $U = M \log \frac{2}{a+\beta}$.

More generally if σ be of the form $p\,f\,(\theta)$, and if $f\,(\theta)$ be put in form

$$f\,(\theta) = A_o + \sum_1^{\infty} (A_n \cos n\,\theta + B_n \sin n\,\theta),$$

we get, if v be greater than λ,

$$U = 2\,\pi\, a\, b\, \Big\{ A_o \log \frac{2}{a+\beta} + \sum_1^{\infty} \frac{e^{-nv}}{n}$$
$$(A_n \cosh n\,\lambda \cos n\,\phi + B_n \sinh n\,\lambda \sin n\,\phi \Big\}$$

and if v be less than λ

$$U = 2\,\pi\, a\, b\, \Big\{ A_o \log \frac{2}{a+b} + \sum_1^{\infty} \frac{e^{-n\lambda}}{n}$$
$$(A_n \cosh n\,v \cos n\,\phi + B_n \sinh n\,v \sin n\,\phi \Big\}$$

9. Since when $\sigma = M\; p/2\,\pi\, a\, b$, the potential of the cylinder is constant, we get for the electric potential of an elliptic cylinder, on which there is a charge M per unit of length

$$V = 2\,M \log \frac{2}{a+b},$$

and the capacity per unit of length is $1/2 \log \frac{2}{a+b}$, reducing to $1/2 \log \frac{1}{r}$ when the cylinder is circular.

If there be two confocal cylinders, the potential and the capacity are most readily deduced from Laplace's equation, expressed with v, ϕ as variables. Obviously, $V = C_1 - C_1 v = C + D \log\, (a + \beta)$ satisfies that equation, and if the outer be at potential A, the inner at potential B,

$$V = \frac{A \log \frac{a+\beta}{a'+b'} + B \log \frac{a+b}{a+\beta}}{\log \frac{a+b}{a'+b'}}.$$

The surface densities will be given by

$$4\,\pi\,\sigma_\mu = \frac{B - A}{\log \frac{a+b}{a'+b'}} \cdot \frac{p'}{a'\,b'};\; 4\pi\sigma_\lambda = \frac{A - B}{\log \frac{a+b}{a'+b'}} \cdot \frac{p}{a\,b}$$

and the charges per unit length

$$E_\mu = \frac{B - A}{2 \log \frac{a+b}{a'+b'}} = -\,E_\lambda;$$

so that the capacity of the inner cylinder is $1/2 \log \frac{a+b}{a'+b'}$.

10. With regard to the equipotential surfaces that are given by the different expressions for U, it may be noted that when the point is outside the cylinder these are either confocal cylinders, or cylinders that at a distance from the attracting matter approximate to confocals. For example consider the case

$$-\,U = M \log \frac{a+\beta}{2} + \tfrac{1}{2}\, M\, e^{-2v} \cos 2\,\phi$$

When v is large, $-\,U = M \log \frac{a+\beta}{2}$ approximately, so that the equipotential surface is a confocal cylinder. Further,

$$\frac{d\,v}{d\,\phi} = \frac{\sin 2\,\phi}{e^{2v} - \cos 2\,\phi},$$

so that v increases with ϕ as ϕ goes from 0 to $\pi/2$. Further,

the curve of section is symmetrical with respect to both axes, so that only values of ϕ between 0 and $\pi/2$ may be considered in tracing the curve. If we put $(M \log \frac{c}{2} + U)/M$ equal to $-f$, the curve will be given by

$$v = f - \tfrac{1}{2} e^{-2v} \cos 2\phi;$$

when $\phi = \pi/4$, $v = f$; when $\phi < \pi/4$, $v < f$; when $\phi > \pi/4$, $v > f$. The curve, therefore, interlaces the ellipse $v = f$, lying within this ellipse when ϕ is between $-\pi/4$ and $\pi/4$, or $3\pi/4$ and $5\pi/4$, and lying outside it in the other cases. It is clearly normal to the axes where it crosses them, and is everywhere concave to the axis of x. A rough tracing of the curve can readily be made from these data.

Again, $v = f - \frac{1}{2} e^{-4v} \cos 4\phi$ would intersect the ellipse $v = f$ in eight points, and so on.

Cases of the form $U = A + B \cosh 3v \cos 2\phi$ are easily discussed; for $\cosh 2v \cos 2\phi = 2(x^2 - y^2)/c^2 - 1$; and $\cosh 3v \cos 3\phi$, $\sinh 3v \sin 3\phi$, etc., can also be expressed rationally in terms of x and y.

INSTITUTION OF ELECTRICAL ENGINEERS.

EXPERIMENTAL RESEARCHES ON ALTERNATE-CURRENT TRANSFORMERS.

BY J. A. FLEMING, D.SC., F.R.S., MEMBER.

(Concluded from page 456.)

We found it essential to standardise the wattmeter on the largest power absorbing arrangement possible, so as to get the greatest possible wattmeter scale reading on a known power absorption in determining the instrumental constant. For if a small power reading was taken, then any error in the scale reading was multiplied up in getting the watts corresponding to a larger scale reading taken from a value of the constant, and sensible errors introduced.

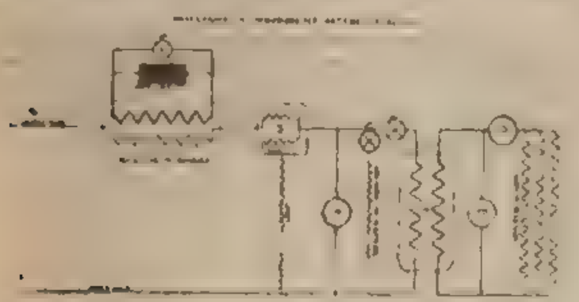


FIG. 4.

In addition to this instrument Mr. Swinburne provided two of his own non-inductive wattmeters. In this last instrument the shunt circuit consisted of a small bobbin of a good many (probably a hundred or more) turns of fine wire, having a resistance of about 300 ohms. In series with this externally, and forming part of the wattmeter shunt circuit, were two doubly wound wire resistances in brass boxes, having a total resistance of about 100 000 ohms, assumed to be practically non-inductive. Provided with these wattmeters, we proceeded to make a series of tests on various transformers of the power absorbed when the transformer was doing secondary work of various loads.

In the tests the transformer had gradually increasing loads of lamps put upon its secondary circuit and whilst the power, W_1, supplied to the primary was measured by the dynamometer wattmeter, that given up by the secondary, W_2, was measured by a Kelvin balance and electrostatic voltmeter placed on the secondary circuit. We measured also the primary current value in amperes corresponding to each definite load on the secondary circuit. We obtained, therefore, for every transformer, the volts, or P.D. across both terminals, the ampere current, and the watt output of the secondary circuit, and at the same time the ampere current and power absorbed in watts by the primary circuit; and hence the difference between W_1 and W_2, or the power lost in the transformer, is also known for each secondary load. Finally, also, the ratio of W_2 to W_1 in percentages can be calculated, and gives us the efficiency. In all these experiments the P.D. on the primary terminals was kept carefully constant at 2,400 volts, and the constant of the primary wattmeter checked at the beginning and end of each series of observations.

A series of tests of this kind was made on each one of the following 10 transformers: A Ferranti 5 h.p. (1885 type), a Ferranti 5 h.p. after having had the primary and secondary circuits both replaced by others of double the length, two 15 h.p. (1892 type) Ferranti, a 20 h.p. (1892 type) Ferranti, a Westinghouse 6,500-watt (the same transformer used by Dr. Hopkinson in his recent tests), a Mordey Brush 6,000-watt, a Thomson-Houston 4,500-watt, a Kapp 4,000-watt, and a Swinburne 3,000-watt "Hedgehog." For each transformer was determined the currents and terminal potential differences corresponding to the various stages of secondary load from no load up to the full nominal output of the transformer, and at the same time the power, W_1, given to the transformer primary circuit, and the power, W_2, taken off from the secondary circuit. The "total lost watts," $W_1 - W_2$, and the efficiency, or ratio, $\frac{W_2}{W_1}$, corresponding to each secondary load, were also calculated. From the known or measured value of the resistances of the copper circuits taken when the transformer was warm and the measured currents we could calculate the copper losses (C^2R losses) in both circuits, separately and together, to the nearest integer, omitting fractions of a watt in most cases; and from the primary volts and current we obtained the value of the "apparent watts" given to the transformer at each stage; and from the "apparent" and "true" watts given to the primary circuit we could deduce the power factor corresponding to any secondary output. The values of the secondary terminal P.D., or volts, gave us also the "total secondary drop" at each load, and from the resistances and currents could be found the "copper drop," or volts lost by resistance. The observations and calculations for each of the 10 transformers tested are given in full in a series of tables.

The results of these numerous observations are set out graphically, and thus represented to the eye, in a series of diagrams. For each transformer four diagrams have been prepared. [We give only a selection of the whole.—ED. *E. E.*]

The first shows the "total lost watts" curve, or $W_1 - W_2$, plotted as a curve in terms of the corresponding secondary output W_2; and on the same diagram is given a curve showing the total copper losses (C^2R) in the transformer in both circuits together. Hence the difference of the ordinates of those two curves gives the value of the losses other than those due to ohmic resistance in the transformer. The second diagram shows the value of the two currents, primary and secondary, plotted in terms of the secondary output. Since all the closed magnetic circuit transformers tested had a transformation ratio and windings in the ratio of 24 to 1, the primary current and $\frac{1}{24}$th part of the secondary current are plotted together on the same scale. The third diagram gives the efficiency curve. The efficiencies in per cents., corresponding to decimal fractions of the full secondary output, are calculated from the "total loss" curve and then drawn. Hence they are all comparable, and we can see at a glance the percentage efficiency corresponding to loads of $\frac{1}{10}$th, $\frac{2}{10}$ths, etc., of the full secondary load. The fourth curve is the "secondary drop" curve, and gives the "total observed drop," the "drop" due to secondary and to primary resistance, and the surplus or "leakage drop," due to leakage of induction, all plotted in terms of the secondary output. The efficiency values are tabulated in Table XXX. for the different fractions of full load for all the transformers.

It is desirable to make one or two remarks about each transformer, and draw some general conclusions. [We only give a portion of these remarks.]

Ferranti Transformers, 1892 Type, 15 and 20 h.p.—These new transformers of Mr. Ferranti's are exceedingly good transformers. The total loss on open circuit of the 20 h.p. is only 1·3 per cent. of the full secondary output. The maximum efficiency is 97·1 per cent., and the efficiency at one-tenth of full load is 85 per cent., whilst the total secondary drop is only 2·1 per cent.

Westinghouse Transformer, 6,500 Watt.—This transformer was one of the pair tested by Dr. J. Hopkinson by his elegant differential method. His results are recorded in the *Electrical Engineer* of July 1, 1892. Dr. Hopkinson's results are placed in the column marked H, those of the manufacturers in column P, and my own in column F; and it will be seen that we all substantially agree in the values of the quantities measured.

Quantities measured.	P.	H.	F.
Watts lost at no load	91	111	98
Watts lost at half load	–	149	141
Watts lost at full load		236	209
Secondary drop at full load	2%	2·2%	2·4%
Efficiency at half load	96·4%	96%	96%
Efficiency at full load	97%	96·9%	96·9%
Total copper losses (C^2R) at full load, in watts	104	—	93

The maximum efficiency is just upon 97 per cent., and its efficiency at one-tenth of full load is nearly 85 per cent.

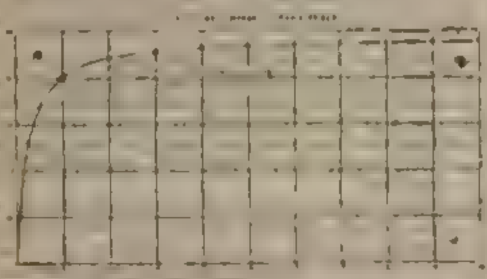
Mordey Transformer, 6,000 Watt.—Two transformers of this size were tested. In one the three-voltmeter method showed the power loss at no load to be 125 watts; in the other, the dynamometer wattmeter gave 148 watts. If we take the mean of these results, we get 136 watts as the open circuit loss. This is 2·27 per cent. of 6,000 watts. According to our observations, this transformer takes rank as one of the best for regulation, having regard to its size and its open circuit loss.

Kapp 4,000 Watt Transformer.—This is a very interesting transformer, having an exceedingly good regulation for such a small size. Its total secondary drop is under 2 per cent. of its secondary voltage at no load, and its open circuit loss is 2·8 per cent. of full output. It is curious in the rather slow rise of its power factor as

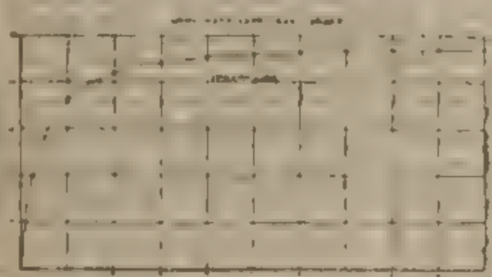
TABLE XXX.—Efficiencies of Transformers Calculated from Curves of Total Losses. From Observations by Dynamometer Wattmeter

Size and description of transformer.	Fractions of full secondary load.												
	0	0·025	0·05	0·1	0·2	0·3	0·4	0·5	0·6	0·7	0·8	0·9	1·0
	Percentage efficiencies.												
6,500-watt Westinghouse	0	61·8	75·9	85·7	91·9	94·0	95·1	96·0	96·3	96·6	96·8	96·9	96·9
3,000-watt Swinburne	0	39·3	56·2	71·7	82·9	87·6	89·8	91·2	92·2	92·8	93·2	93·4	[illegible]
4,500-watt Thomson Houston	0	49·1	65·4	78·8	87·8	91·1	92·9	93·8	94·2	94·6	95·0	[illegible]	94·7
20 h.p. 1892 pattern Ferranti	0	62·0	76·6	86·5	92·6	95·0	95·6	96·1	96·5	96·8	96·8	[illegible]	[illegible]
15 h.p. " " "	0	66·5	79·0	88·1	93·4	95·0	95·7	96·0	96·2	96·3	96·1	95·8	[illegible]
15 h.p. " " " (re-wound)	0	55·0	70·8	83·0	90·5	93·1	94·5	95·1	95·4	95·5	95·4	95·2	94·7
6,000-watt Mordey	0	52·1	67·6	80·1	88·5	91·1	92·7	93·7	94·2	94·7	94·9	95·1	95·1
4,000-watt Kapp	0	29·5	55·5	72·3	83·8	88·0	90·4	91·9	92·6	93·3	93·8	94·0	94·2
5 h.p. 1885 pattern Ferranti (re-wound)	0	28·8	44·5	61·4	75·6	81·9	85·5	87·7	89·0	89·8	90·2	90·5	[illegible]
5 h.p. " " "	0	14·6	25·3	40·3	57·2	66·5	72·5	76·4	79·1	81·5	83·1	84·5	[illegible]

the secondary load is increased. The good regulation of the transformer and small "leakage drop" are no doubt due to the effective "sandwiching" of the primary and secondary coils.



Efficiency Curve—6,000-Watt Mordey Transformer.



Efficiency Curve—4,000-Watt Kapp Transformer.

Swinburne 3,000 Watt "Hedgehog" Transformer. Lastly, but by no means least, there are several remarks to make about the "Hedgehog" transformer of Mr. Swinburne. The mean of all means of over 62 observations by three different methods gives the value of 112 watts for the power absorbed at no load in this 3,000 watt "Hedgehog" transformer.

GENERAL REMARKS ON THE ABOVE EXPERIMENTS.

On examining all those diagrams in which are delineated the curves of total loss of power in the transformer and the curve of total copper resistance loss, C^2R, it is found that in every case the upper curves are *sensibly parallel*. In the curves for closed magnetic circuit transformers of good design the difference between the total C^2R loss and the total loss of all kinds is the iron core loss in the transformer. Hence we see that all the experiments lead to the conclusion that *the iron core losses are constant at all loads*. In no case have we found any substantial evidence that the iron core losses are evanescent at full secondary load. This last view has been held by Mr. Mordey and others. Seeing that our methods, when applied to the 6,000 watt Mordey transformer, give practically the same results at no load as Mr. Mordey obtains, it is an interesting matter to enquire how it comes to pass that the calorimetric method employed by him seemed to indicate that the whole loss in the transformer at full load was accounted for by the frictional losses in the copper. At present the writer can offer no explanation of this discrepancy. The above-described observations were all made and plotted out before the appearance of the paper of Prof. Ayrton and Dr. Sumpner, and shown to many people, but it is very satisfactory to find that their undoubtedly excellent method has conducted them to precisely the same conclusion. Hence we seem to have very good reason to believe that the total internal loss curve of a transformer can be drawn from observations of the C^2R losses and the total core loss at no load.

When we come to consider it, it is very difficult to see on what valid supposition we could conclude that hysteresis loss should be less at full than at no load. The only difference in the magnetic conditions are that in one case the iron is magnetised by a small current acting in one direction, and in the other by the difference between two currents flowing in opposite directions, but governed by the condition that the total ampere turns remain the same. In a special experiment I have taken the hysteresis diagram for a soft iron wire employing a magnetising force of 1,000 ampere turns, in one case produced by 2·5 amperes and 400 turns, and in the other case by 20 amperes and 50 turns. The hysteresis areas for a complete cycle were found to be practically the same—the [illegible] if anything, the larger of the two. Prof. Ewing's direct [illegible] on this point will be remembered.

These measurements have brought out, in addition, another very interesting fact. In the tables for each transformer is given a column of figures headed "Power factor." We have already defined this term as the ratio of the "true watts" to the [illegible]ent watts," or product of the effective amperes and effective volts. This ratio is given for each measurement of the power. We see at once that for closed magnetic circuit transformers of good type, such as the Mordey, Westinghouse, Ferranti, etc., the power factor at no secondary load begins at a value of about 0·8 or thereabouts. For such types of transformers, however, a very little loading up of the secondary circuit—not more than one-tenth of full load—brings the power factor up to unity. For an open magnetic circuit transformer like the "Hedgehog" the case is quite different. The P.F. begins at a value of 0·08 or 0·06, and it never rises up above 0·8. Hence at no stage of the load is the real power taken up by the transformer anywhere nearly equal to the "apparent watts." A transformer like the 4,000 watt Kapp appears to occupy an intermediate position, and although it has a medium power factor to start with, its P.F. rises up to unity at about half load. The importance of this fact in alternate-current station working is very great. It shows us, if we have a station wholly supplied with transformers of the type of Mordey, Westinghouse, Thomson Houston, Ferranti, etc., that the apparent watts supplied to the transformers is the real watts at any hour when all the transformers are more than one-tenth loaded. If, however, the station is engineered with "Hedgehogs," or with that museum of transformers of all sorts and makes which some central station engineers are fond of gathering together under the idea, perhaps, that they can "hedge" for economy and make up for the vices of one kind by the virtues of another, then in hardly any state of the load will it be safe to assume the identity of the true and apparent measures of outgoing power. We must, of course, here assume that concentric primary cables are not in use, otherwise an error of another kind may be introduced. If we take the case of a station provided wholly with closed magnetic circuit transformers, and consider it as having an average kind of load diagram, say for the whole year, then if the measure of the "apparent units" sent out from the station is taken, I do not think that in general we shall be far out in our estimate of the true units sent out if we deduct from the apparent units about 12 to 15 per cent. and call the remainder the measure of the true units of energy sent out in the whole time.

[A large part of the paper here was concerned with the incorrectness of a Swinburne wattmeter, which the author suggested had led Mr. Swinburne to wrong conclusions as to the value of the Hedgehog transformer.]

CONCLUSION.

There are very many derivative matters which, if space permitted, might be discussed as consequences of facts observed in the course of the above-described researches. It is evident, for instance, that the last word has by no means been said on the subject of design of transformers. I have every hope that before long transformer manufacturers may be able to produce transformers of 25 h.p. and upwards having close upon 90 per cent. efficiency at one-tenth of full load. When that is done, it will be interesting to repeat some of those calculations which have already been made as to the relative cost of delivering a certain [illegible] of thousand units on an average load diagram, say for distances of 1,000, 2,000, 3,000 yards, etc., by low pressure feeders and by high pressure plus transformer feeders. [illegible] can be made with some degree of confidence now that it [illegible] clear that the iron losses in transformers are constant at all loads, and that there is a definite relation between this loss and the open circuit or magnetising current. We can hardly regard the great controversy of open versus closed magnetic circuits as entirely and definitely settled, but there is no reason to believe that the majority of those who have designed transformers with closed magnetic circuits have been supremely unwise in their faith or in their work.

In the matter of transformer testing the experience gained in obtaining the facts brought before you has established in the writer's mind at least the feeling that a properly constructed dynamometer wattmeter is perhaps the best workshop instrument

to use for this purpose, but that its personal character must be strictly examined before trusting too implicitly to the results obtained by it.

In conclusion it will only be right to make mention of those who have assisted me in the somewhat arduous work of taking the observations here recorded. The principal share of this has been borne by my assistant, Mr Shields who has worked with great perseverance and care for many months in taking the actual observations, and this in many cases required some painstaking work. He was assisted at intervals by Messrs J. and D. Morris, students in University College, London, especially in those observations in which the careful simultaneous reading of several instruments was required. The observations on the sudden rush of current into transformers were made for me by Mr. Wordingham.

The facts and measurements thus obtained have in all cases been sifted and repeated with the greatest possible care, with the desire to arrive at conclusions which should be worthy of confidence, and useful to those engaged in transformer manufacture and design.

INSTITUTION MEETING, December 1.

The formal business of reading the minutes was duly carried out, and the following gentlemen were balloted for and elected:

Members.—William D. Hunter, Newcastle and District Electric Lighting Company, Newcastle on Tyne; William Johnson, Sheffield Electric Light and Power Company, Sheffield.

Associates.—J. W. Chisholm, Central Electric Lighting Station, Whitehall road, Leeds; Captain Thomas Harrison, R.E., Burmah.

The discussion on Dr. Fleming's paper was then commenced by **Mr Swinburne**, who referred in the first place to the electrostatic voltmeter and its damping arrangements, stating that they had tried oil damping but preferred the electromagnetic; and also to the sparking of the voltmeters, explaining that the voltmeter used was designed for 1,200 volts, and was tried with 2,500. He did not like mica because it introduced difficulties in calibration. Turning to the wattmeter the speaker had for at least five years suggested the use of the wattmeter, but the professors had objected to it because of its simplicity. Nothing mattered to the Professor if it were sufficiently complicated. In the paper it was inferred that his wattmeter was educated up to read experiments on the Hedgehog. The speaker explained how it came to pass that this particular wattmeter was wrong. He found that capacity did not cause the error in the wattmeter. Dr. Fleming's suggestions were not correct, but the real error was due to Foucault currents in the brass case, and the speaker explained this by means of a diagram. Coming now to the important part of Dr. Fleming's paper, the speaker agreed as to the value of the wattmeter for testing purposes. The next point definitely settled was they could calculate efficiency at full load, in that the loss in the iron was constant, or nearly so. A third point unsettled was the value of the open compared with the closed circuit transformers. The speaker agreed that the particular transformer sent to Dr. Fleming and tested by him was not a good one. As regarded the eddy currents in the copper, these were first investigated by Sir W. Thomson, and after this investigation Mr. Swinburne had made a table and used wire that ought not to have had eddy currents. He had tried removing the secondary circuits and found no difference; he removed the phosphor bronze and the ends and found no difference. Recently, however, he thought they had found the point of difficulty, in the Foucault currents in the core. He protested against the use of power factors for all transformers, as it would lead to error, but agreed with the importance of cost and weight. He referred to a paper relating to the drop of a transformer which appeared in *Industries*, and if that were correct then Dr. Fleming's argument was altogether wrong. He found that condensers broke down in switching off rather than in switching on, and he thought the reason was due to a kind of arcing effect, and not that given by Dr. Fleming. In conclusion, the speaker called attention to a station wattmeter exhibited to the meeting.

Prof Forbes agreed as to the value of the paper, if only in teaching Mr. Swinburne to make an accurate wattmeter and a good transformer. Hitherto people thought all transformers had somewhat the same efficiency. Dr. Fleming's experiments had corroborated his own experiments with the Westinghouse transformer. Great attention had justly been paid to making transformers efficient at light loads, but the future might give rise to sub-stations and larger transformers, when the great efficiency at low loads would not be of such great importance. Efficiency at different loads meant designing the proper proportion of copper and iron for the particular load where efficiency was required. Somewhat the same held good when power was transmitted from a water motor; the efficiency was required at full load and not so much at low load. He had found that at Niagara the cost of transformers with much copper would be more than that of the dynamos, with less copper and lower efficiency at low loads, the cost was half or one third only.

Mr Kapp thought the paper of Dr. Fleming of unique interest. He had the more confidence in that the figures were evidently in no way cooked, 100.1 per cent. being given as the result of one experiment though impossible. He looked upon the paper as an absolutely reliable record of the present state of transformer practice. Dr. Fleming had used the wattmeter system, and although this system had been used at Frankfort with standardised instruments, he preferred the voltmeter method. He took three readings with the same voltmeter, using mercury contact changes, and found that by taking four sets he obtained very consistent results. Since the publication of Dr. Fleming's paper he had himself made tests to see the effect of the heavy copper core, taking one transformer with a thick copper winding, and another with exactly similar core wound with thin wire. He found that the loss was with the thick wire 120 watts, including hysteresis, and with thin 130 watts, so that there was no great difference from the cause. The researches of Dr. Fleming would be of the greatest utility in enabling engineers to decide upon the relative value of direct and transformer systems. Until now they had been working in the dark, assuming a low efficiency at one-twentieth load. Now it is found that it is possible to get transformers with 75 per cent. efficiency at one-twentieth load, and 85 per cent. at one-tenth load. The load at central stations never sunk below one-twentieth, and this lowest load tends to improve. Even at lightest loads, therefore, transformers give 80 per cent., and at heaviest load 96 per cent.—a high average over the whole. But in the direct current system, where the feeders lose 20 per cent. at heaviest load, the loss is evidently greatest at the time of highest load, whereas with transformers the greatest loss is with the light load. Engineers would work with more confidence after this paper by Dr. Fleming.

The **President** asked Mr. Kapp whether in his test of the transformer, the transformer was closed or open magnetic circuit, whether the fine wire were inside or out, and whether he magnetised the inner or outer core, and whether he transformed up or down.

Mr Kapp replied it was with closed magnetic circuit, thick copper, next the core, thin outside, pressure 100 volts. The same carcase was used with thin wire in the same position as thick wire. The transformer was of the Brown Boveri type, transforming up.

The **President** said the conditions, therefore, were not the same, as if he had tried transforming down. He would deal with this point in his remarks.

Mr Evershed thought that before the discussion on this admirable paper closed attention should be given to the history of the investigations into the theory of transformers. Passing by the theories of the early constructors, he directed attention to the labours of Prof. Ryan in America, whose paper, he contended, really solved most, if not all, the problems connected with transformers. That paper received very little attention here. Mr. Mordey's well known experiments, which were in direct opposition to those of Prof. Ferraris, were also referred to, and the speaker hinted that probably Mr. Mordey had by this time begun to think his view of the case might be wrong. The speaker had at the time as had some others, combatted the views of Mr. Mordey, but found that Prof. Ayrton also agreed with Mr. Mordey, and accepted the results of his students' investigations as correct. Hence he thought he might be wrong, though it seemed to him that Prof. Ayrton's conclusions were contrary to nature's laws. Then came Mr. Swinburne's paper on the design of transformers, which was carefully studied in America, and this paper together with that of Prof. Ryan, led the Americans to do better with transformers than in this country, and he was glad to find an American transformer coming out at the top of the tree in Prof. Fleming's experiments, and felt it was only just what they deserved. He referred to his own experiments in collaboration with Mr. Vignoles, the results of which were in accordance with those of Prof. J. Hopkinson, but it was not till the publication of Dr. Hopkinson's results that the professors began to be converted, and he assured them that there was more joy in that Institution over one professor that repented, than over ninety and nine who continued in the way of error.

Mr. W. B. Sayers sent a communication, pointing out that as with a conductor, where alternate currents were used, the magnetic circuit was not affected to the same depth. The centre of the metal was not magnetised to the same extent as the outer, and the skin might even be opposite by reason of the eddy currents.

Mr Evershed said this matter had been fully gone into by Mr. Swinburne and himself, and they had found that the effect was very small. In extreme cases the induction in the centre of the iron magnet might be 2 per cent. less than outside.

The **President** then stated that the further discussion on Dr. Fleming's paper would be adjourned to the meeting next Thursday, and that Sir D. Salomons would explain a new machine which was exhibited on the table.

Sir D Salomons then explained that his work was the outcome of Mr. Tesla's investigations. He was sorry he could not show the machine in action, but he thought it right to show it first to the Institution. They must take his word for it that it had worked. The machine was for the purpose of producing alternating currents of very high frequency from ordinary direct currents. It had been made by Mr. Pyke, of Pyke and Harris, who had given much attention to the question of high frequency currents. It consists of two discs, whose outer rings are slotted into 360 slots, the magnetism in one side of the machine producing induction in the other. The diameter is only 1ft., so that to give sufficient alternations it had been made so that both rings revolved at 1,500, so that the passing speed was 3,000 revolutions. This, by 360, gave over a million revolutions per minute, if every alternation acted, as he has every reason to suppose was the case. They had given it the name of "directo alternating current transformer." The interior of one side formed the fields of an ordinary motor, and the other a Gramme ring. Sending current in, made them revolve in opposite directions. The current used was ½ ampere at 200 volts, and he had certainly got up to over 100,000 volts. This he had taken without unpleasant effect through the body, and lighted vacuum tubes thereby.

THE

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NOTICE.

With this issue of the Paper is given a Supplement containing Portraits, taken from photographs, of **Mr. Magnus Volk, Mr. Chas. Capito, Mr. Henry F. Joel, Mr. F. M. Newton,** and **Mr. George Offor.**

Every reader should see that he gets this Supplement, and non-delivery with the Paper should be reported at the Publishing Office.

THE INSTITUTION BALLOTING LIST.

In another column will be found the Institution's Council list of those names suggested for official positions during the forthcoming year. On several previous occasions it has been our good or bad fortune to have given publicity to adverse criticisms on the tactical management of the Institution. It will be remembered that some years ago, owing to the expression of opinions from outside members, the Council adopted the plan of giving alternative names. In many respects this was a better plan than the present, but was found to have insuperable objections, due principally to "human nature." An examination of the matter soon shows how great the difficulty. Gentlemen are approached by the Council to ascertain if they will serve if elected. Now, if six gentlemen are nominated from the Council and only three can be elected, three have to stand out in the cold—it may be with a very few votes to their names. Such a position is an unpalatable one, and not desired by the majority of people. It may, and often is, taken to mean that, in the eyes of the Council, who should have a good opportunity of knowing eligible parties, a man is considered eligible who, in the estimation of the majority of members, is only fit to be placed at the bottom of the list. If human nature was not such a huge factor with members of the Council as well as with ordinary members of the Institution, the selection of eligible candidates by the Council would be the best possible way of ensuring a competent Council. Unfortunately, however, there is too great a tendency to form a ring rather than to ensure due, and not undue, representation of every branch of the profession. The welfare and reputation of the Institution is, if not lost sight of, relegated to the background in the effort to ensure the continuation of ruling as it exists. And yet everyone who considers the question will agree that continuity of action is a necessity, and no one would wish to upset a Council which conducted the business fairly well by new brooms that wanted to change everything. We have not the slightest doubt but that the Council are fully alive to the difficulty of pleasing everybody, and we take it as a sign of strength rather than of weakness that they say, These are the men you ought to elect, rather than leaving selection to a working clique or the haphazard selection of a lucky-bag. The number of members who take any great interest in the selection of Council is comparatively small, and composed of two bodies—the one supporters of the existing Council, the others supporters of those who would like to be on the Council. It is unnecessary to say that membership of the Council to practical business men has a considerable value, even though that value cannot be gauged in pounds sterling; therefore ordinary members should be somewhat jealous of those submitted for their approval. The present selection of names will not, as we say, please everybody, but on the whole the support of the members should be with the action of Council. Give the officers full confidence or nothing in those matters which are of vital import.

THE SPECIALISATION OF ACCUMULATORS.

We are rapidly coming to the time when it will be considered as loose to speak about or specify an "accumulator" as it is to specify a "dynamo." The time was, and not so many years ago, when, for ordinary purposes, there was only one kind of dynamo made—the shunt Gramme ring type—and this was used for any purpose that might be required, bolstering up its incapacities with resistances or other makeshifts. Nowadays, the requirements of a situation are accurately determined, and the dynamo is specified and made—direct or alternating, shunt or compound, or over-compounded, with light fields or heavy fields, large air gap or small air gap—according to the conditions for which it is required. The same specialisation of the accumulator has not yet been achieved, but it must come. There are two entirely different ways of considering the accumulator, as we have already had occasion to point out, in that the accumulator may be considered, in any generating plant, either as belonging to the plant, the capital side of the account, or to the fuel or maintenance side. The tendency which at first was to consider the accumulator entirely as plant has lately swung over, to a very large extent, to the tendency to consider it as a factor in the maintenance account. The two points of view are distinct. They require different methods of calculation and arrangement. Both are equally necessary, and although it is evidently well to pay attention to the maintenance theory, the other must not be left too much out of account.

The two views differ more particularly in this: that, considered as plant, the accumulator should be of the utmost perfection at all points, price being to a large extent a secondary consideration. The same thing is seen with other plant—dynamos, for instance. Where power is dear, it is certainly better to buy the very best dynamo, even if considerably dearer. On the other hand, if the accumulator is to be considered as maintenance, an item to be gradually used up, of the same relation, in fact, to the output as coal itself, then cheapness, combined with a fair efficiency, is the quality required, the wearing out being calculated as part of the cost of production of the current. On the one hand, then, the accumulator is deserving of the same extent of skill of investigation and improvement which has given us the dynamo of 98 per cent. efficiency, and on the other, is subject to the same considerations which lead an engineer to select his type of coal. Requirements differ, and accumulators, therefore, must receive the same amount of specialisation that has been given to the dynamo, each occasion for their use being considered on their merits. We shall find, primarily, four different types of accumulators—portable, traction, house, and station cells. The requirements for the first are extreme lightness, with capacity for a steady discharge; the traction cells are also required to be light, but with the capacity of responding without deleterious effect to uneven and heavy discharges; the third, the house cells, are required to be of a nature not necessarily very light in weight, which can be charged regularly, will render a high efficiency at steady discharges, and will maintain their charge without local action for days or even weeks; the fourth, the station cells, also need not be light, but must be able without bad effect on the plates to respond to heavy and sudden demands to fill up the breach in case of failure of dynamo, for a few hours at a time. Now these requirements differ almost as largely as those for dynamos, and in the same way that the cost, proportions, and weight of these machines are considered beforehand and provided for by the designers and manufacturers, must the design and manufacture of secondary cells be considered. A method of perfection costing a shilling or two extra for accumulators would not, perhaps, be worth application for one type of plate, which might render the most efficient service for another. We make, therefore, a plea to both consulting engineers and manufacturers for still further efforts in the direction of the specialisation of accumulators, confident that greater attention to this point must prove of advantage to the industry at large. Qualities that militate against the use of one type of cell may certainly prove of advantage in other fields of work, and it will be of utility that the outside consumers should be aware that they can obtain cells of this or that character as accurately as they now can their dynamos.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WHAT IS THE USE OF A SHUNT TO A GALVANOMETER?

SIR,—I am a very puzzled student, but no doubt what is mud to me is clear water enough to somebody. I wish that somebody would help to improve my mental condition in this matter. I am told that a shunt is used with certain galvanometers so that the galvanometer coils shall not get too much current—hence get heated too much ($C^2 R$). I am told that putting in a shunt or 20 shunts does not alter the current in the original conductor, providing pressure is constant. What is the shunt for—to lessen the pressure, to prevent heating, or what?—Yours, etc.,

A PLUCKED STUDENT.

ACCUMULATORS: CHEAPNESS v. EFFICIENCY.

SIR,—The letter of Mr. Frank King, in your last issue, carries internal evidence that it was written under the influence of several misapprehensions.

In the first place, I may state, on my own responsibility, that the remark of which Mr. King complains *can* be substantiated with about the same facility as it can be made. Can Mr. King state definitely that his company do *not* "favour cheapness rather than extreme efficiency"?

I can at the same time, so far as my experience goes, confirm Mr. King's remark that the E.P.S. accumulators will compare favourably, both for efficiency and durability, with any type of accumulator at present manufactured (on a large scale). I have no reason to think that the *Electrical Engineer* differs from me in this view.

This being the case, I am puzzled to understand what Mr. King can mean when he speaks of "questionable means of advertising so-called new inventions by unfair comparison with the company's goods."

Is my patented device of throwing down a slight film of gold upon the surface of a grid, intended to carry peroxide, a "*so-called* new invention"? If so, is it an old invention, or is it no invention at all? In any case, how could it possibly be compared, fairly or unfairly, with "the com-

pany's goods"? The process was devised to improve, not to compete with, pasted-grid accumulators. Of course, Mr. King has a perfect right to his own opinion respecting the practical value of this device in obviating the local action in the peroxide plate, an action involving a continuous loss of energy, and the ultimate destruction of the plate. But, as he has not tested the effect of the gilding, his opinion can scarcely be worth much.—Yours, etc.,

DESMOND G. FITZGERALD.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

VI.—OHM'S LAW AND THE ELECTRIC CIRCUIT.

(Continued from page 537.)

Calculation of Resistance.—The resistance of a conducting wire depends on three things: 1. Its length. 2. Its diameter, or cross sectional area. 3. Its specific resistance, or substance it is made of.

The resistance of a conducting path varies directly with its length, so that a conducting wire 200 yards long has exactly double the resistance of one that is 100 yards long. The resistance of a conducting path varies inversely as its cross-sectional area, or inversely as the square of its diameter (area being proportional to the square of the diameter), so that the thinner a conducting wire becomes, the greater is its resistance. A wire having an area of one square inch has one-half the resistance of a wire having an area of half a square inch, and if the size of the wires be expressed in their diameters, then a wire of ½in. diameter has four times the resistance of a wire of 1in. diameter, and a wire of 2in. diameter has a resistance of one-fourth of the resistance of the 1in. wire. The square of 1 is $1 \times 1 = 1 = d^2$, the square of $\frac{1}{2} = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4} = d^2$, and the square of $2 = 2 \times 2 = 4$, and since the resistance varies inversely as the square of the diameter, we therefore have—

First wire $d = 1$in. $\therefore d^2 = 1 \therefore \frac{1}{d^2} = 1 \therefore$ ratio $= 1$

Second " $d = \frac{1}{2}$in. $\therefore d^2 = \frac{1}{4} \therefore \frac{1}{d^2} = 4 \therefore$ " $= 4$

Third " $d = 2$in. $\therefore d^2 = 4 \therefore \frac{1}{d^2} = \frac{1}{4} \therefore$ " $= \frac{1}{4}$.

The resistance of a conducting path varies directly with its "Specific resistance."

The specific resistance of a substance signifies the resistance it has compared with the resistance of some substance taken as a standard, both substances being of absolutely the same dimensions and under the same conditions, such as temperature, etc. The specified dimensions are expressed either in French or in English measures. When the former are used the specific resistance of a substance is that given by a mass having a cross-sectional area of one centimetre and a length of one centimetre; when the latter is used it is that given by a mass having a cross-sectional area of one square inch and a length of 1in., the resistance in each case being measured lengthwise. The "Relative resistance" of a substance signifies simply the resistance as compared with a standard, no matter what the dimensions are, provided they are the same for each. Respecting the relative resistances of three substances—silver, copper, and iron—it will be found that giving unit resistance to silver, the values for copper and iron will be 1·06 and 6·4, or putting silver at 100, the others will be 106 and 640. From this it is seen, that having two wires, one of copper and the other of iron, both having the same diameter and length, the resistance offered by iron wire will be six times as much as that offered by the copper wire, because $6·4 \div 1·06$ or $640 \div 106 = 6$, roughly.

The specific resistance of pure annealed silver in English measure—that is, of a mass having one square inch area and 1in. length—is about ·000000633, or $\frac{1}{1580000}$ of an ohm, therefore the resistance of a bar of silver of 1in. area and 1ft. long will be ·0000076, or $\frac{1}{131579}$ of an ohm; this is with a temperature of, say, 18deg. C., or nearly 65deg. F., which may be taken as a fair average temperature of the atmosphere in England. Knowing the relative resistance of any substance at the same temperature, its resistance could be easily calculated out per square inch foot by multiplying the resistance of a square inch-foot bar of silver by the relative resistance, the question of length and area can then be treated according to the laws previously given. The enormous high cost of silver naturally entirely prohibits its use as a conducting wire, and the next best conductor is copper, which is only a little way behind silver in question of conductivity. Although far below silver in price, copper is an expensive metal, ranging from £50 to £80 per ton, according to the state of the copper market. The capital that must be sunk in copper for feeders and distributing mains for a certain electric light station comes to a very heavy sum, sometimes one-third of the total cost, and, as may be expected, the price of the metal is bound to become more expensive as time goes on, on account of the increasing annual consumption, due to a great degree to the progress of electric work. This is assuming that no large sources are discovered.

Copper is the only metal that is used for conveying electric currents for lighting purposes, and it is used in nearly all cases for electric transmission of power and traction. There are some tram lines where silicon bronze wire instead of copper is used, but these form an exception. We will now proceed to work out a practical formula for calculating quickly and easily the resistance of a copper conductor.

The resistance of a bar of pure hard drawn copper, 1ft. long and 1in. diameter, may be taken as ·0000105, or [illegible] of an ohm. The commercial conductivity of good copper should not be under 98 per cent. of that of the pure copper, and since conductivity is the reciprocal of resistance, therefore the resistance of commercial copper should not be greater than 102 per cent. that of the pure copper. Making this correction, we find the resistance of the above bar for commercial copper will now be ·0000107, or [illegible] of an ohm. This is for a temperature of 18deg. C.

Three thousand feet or 1,000 yards of No. 13 legal standard gauge (L.S.G.) copper wire, having a diameter of ·104in., may be taken as measuring about three ohms of resistance at 18deg. C. or 65deg. F., the conductivity being 98 per cent.

To calculate the resistance of any sized copper conductor having conductivity of 98 per cent., apply the following rule. Divide the length in feet by 93,000 times the square of the diameter in inches; the quotient will give the resistance in ohms. That is,

$$\text{Ohms} = \frac{\text{Length in feet}}{(\text{diameter in inches})^2 \times 93{,}000},$$

$$\text{or, } R = \frac{L}{D^2 \times 93{,}000}.$$

When resistances are very high they are expressed in megohms, one megohm signifying one million (1,000,000) ohms.

When resistances are very low, they are expressed as microhms, one microhm signifying the one millionth part ($\frac{1}{1000000}$) of an ohm.

When currents are very small in value, they are expressed as milliamperes, one milliampere signifying the one thousandth ($\frac{1}{1000}$) part of an ampere, but this small unit is rarely used.

A few examples will now be given of applying Ohm's law, and the rules given for calculating resistances.

1. A dynamo working at 110 volts pressure at its terminals, feeds a bank of incandescent lamps having a total resistance of ·2 of an ohm; how much current do they take?

Applying Ohm's law we have $C = \frac{E}{R}$ and inserting values for E and R we get $C = \frac{110}{·2} = 550$, hence 550 amperes is the current taken by the lamps.

2. How many volts are required to force a current of 48 amperes through a circuit having a resistance of three ohms?

$$E = C\,R = 48 \times 3 = 144\,.$$

Hence 144 volts would be required.

3. Find the resistance of a circuit where 40 incandescent lamps, each taking ·5 of an ampere, are run at a pressure of 100 volts.

The total current will be $40 \times \cdot 5 = 20$ amperes, therefore

$$R = \frac{E}{C} = \frac{100}{20} = 5.$$

Hence the resistance is five ohms.

4. A certain copper wire has a resistance of three ohms. If this were replaced by an iron wire twice as long and half the diameter, what would be its resistance? First of all, the relative resistance of iron is, say, 6·4, and that of copper is 1·06, hence the iron wire has $(6{\cdot}4 \div 1{\cdot}06)$ times as much resistance as the copper wire,

or, $$\frac{6{\cdot}4}{1{\cdot}06} \times 3 = \frac{19{\cdot}2}{1{\cdot}06} \text{ ohms.}$$

Second, the iron wire has double the length of the copper wire, and has one-half the diameter, so the resistance must now be multiplied by 2 and again by 4,

or, $$\frac{19{\cdot}9}{1{\cdot}06} \times \frac{2}{1} \times \frac{4}{1} = 145 \text{ nearly.}$$

Hence its resistance is 145 ohms.

5. Calculate the resistance of a copper wire 150 yards long and ¼in. diameter. Applying our rule we have

$$R = \frac{L}{D^2 \times 93{,}000} = \frac{450}{{\cdot}0625 \times 93{,}000} = {\cdot}077$$

Hence the resistance is ·077 of an ohm.

6. A dynamo working with 100 volts pressure at its terminals delivers a current of 10 amperes to a group of lamps 200 yards distant; there must not be a greater drop of potential along the line than 2 per cent. What must be the diameter of the wire used?

As the total loss is 2 per cent., this is two volts drop, or one volt drop in sending the current from the dynamo to the lamps, and one volt drop in returning from the lamps to the dynamo. We have now to find what resistance will absorb one volt in forcing 10 amperes through it. This evidently is $\frac{\text{volts}}{\text{amperes}} = \text{ohms}$, or $\frac{1}{10} = {\cdot}1$ of an ohm, so that a resistance of one-tenth of an ohm will cause a drop of one volt in sending 10 amperes through this resistance. From this, it is seen that one length of wire between the dynamo and the lamps—namely, 200 yards—must not have a resistance more than ·1 of an ohm; similarly for the second or return wire. The length and resistance are given, and the diameter is wanted.

Now, $$R = \frac{L}{D^2 \times 93{,}000} \therefore D = \sqrt{\left(\frac{L}{R \times 93{,}000}\right)};$$

$$\therefore D = \sqrt{\left(\frac{600}{{\cdot}1 \times 93{,}000}\right)} = \sqrt{({\cdot}0645)} = {\cdot}254.$$

Hence the required diameter of the wire is a little over ¼in.

Conductors and Insulators.—All substances, so far as we know, will conduct electricity to a greater or less extent, and the property which a substance has for conducting, or acting as a medium for the passage of electricity, is named its "conductivity." A good conductor offers little resistance, and a bad conductor offers great resistance; a bad conductor is called an insulator, so that a good conductor acts as a bad insulator, and a good insulator acts as a bad conductor. The various metals conduct best, hence their conductivity is very high; silver takes the first place, and is put down as the standard. Copper follows close behind, and the other metals take their place in order. Acidulated liquids come next, then other liquids, such as sea and fresh water, etc. (oils excepted); wet wood is considered as a partial conductor, hence great care should be exercised in seeing that the wood enclosing or supporting conductors is sound and dry. Dry wood belongs to insulators; nearly all other materials are classed as insulators.

There is no defining line between conductors and insulators, as may be judged by the note just given respecting wood. It was stated that there is no substance that absolutely checks the passage of electricity, and, on the other hand, there is no substance that does not offer *some* resistance. Hence, we may divide substances into two classes—one class to conduct electricity, called "conductors," and the other class to stop electricity, called "insulators."

In the following table, the best conductor is placed first. Half-way through the list the conductors have such bad conductivity that the next commences the insulator class, and those following have been put as near as possible in their proper order; the nearer the end of the list, the worse the conductivity or the better the insulator. It is difficult to say exactly as to the relative position which several insulators at the bottom of the list should occupy. There seems to be little reliable information. Some insulators lose a good deal of their insulating quality as time goes on, so that although tests will give a very high initial result, it is found that they drop off considerably after use, and so become of lower insulating quality than others that were initially lower, but remained fairly constant.

TABULATION 15.

Classed as Conductors.	*Classed as Insulators.*
Silver.	Dry wood.
Copper.	Cotton.
Silicon bronze.	Marble.
Gold.	Paper.
Aluminium.	Oils.
Zinc.	Porcelain.
Phosphor Bronze.	Wool.
Platinum.	Silk.
Wrought iron.	Sulphur.
Tin.	Sealing wax.
Cast steel.	Resin.
Lead.	Vulcanised bitumen.
German silver.	Mica.
Platinoid.	Guttapercha.
Mercury.	Flint glass.
Carbon.	Shellac.
Acids.	Vulcanised indiarubber.
Sea-water.	Ebonite.
Fresh water.	Paraffin wax.
The body.	Dry air.
Wet wood.	

The various woods possess a great difference in resistance; the best insulator is put first in the following list:

Teak (best).	Lignum Vitæ.	Pine.
Walnut.	Rosewood.	Mahogany (worst).

The following tabulation gives the relative conductivity of some of the more important materials used as conductors and insulators:

TABULATION 16.

Material.	Conductivity.	Material.	Conductivity.
Silver (annealed)..	100	Mercury	1·6
Copper (hard drawn)	92	Carbon	0 05
Silicon bronze......	90	—	—
Phosphor bronze..	24	Mica	$\frac{1}{6 \times 10^{17}}$
Platinum...........	16·6	Guttapercha	$\frac{1}{30 \times 10^{17}}$
Wrought iron......	15·6	Flint glass	$\frac{1}{300 \times 10^{17}}$
Cast steel	9·6	Shellac	$\frac{1}{600 \times 10^{17}}$
Tin	11·4	Indiarubber (vulcanised)	$\frac{1}{1{,}000 \times 10^{17}}$
German silver	7·2	Ebonite	$\frac{1}{1{,}900 \times 10^{17}}$
Platinoid..	4·4	Paraffin wax	$\frac{1}{2{,}300 \times 10^{17}}$

The last seven materials are insulators of the best kind, and their enormous resistance as compared with the conducting metals can be observed.

It may be mentioned that 10^{17} signifies one hundred thousand million millions (100,000,000,000,000,000).

(To be continued.)

A NEW ELECTRICAL DISTRIBUTION SYSTEM.

Certain improvements in electrical distribution have recently been completed by Messrs. J. E. H. Gordon, which have been patented by their chief engineer, Mr. T. Tomlinson, by whom the improvements have been devised.

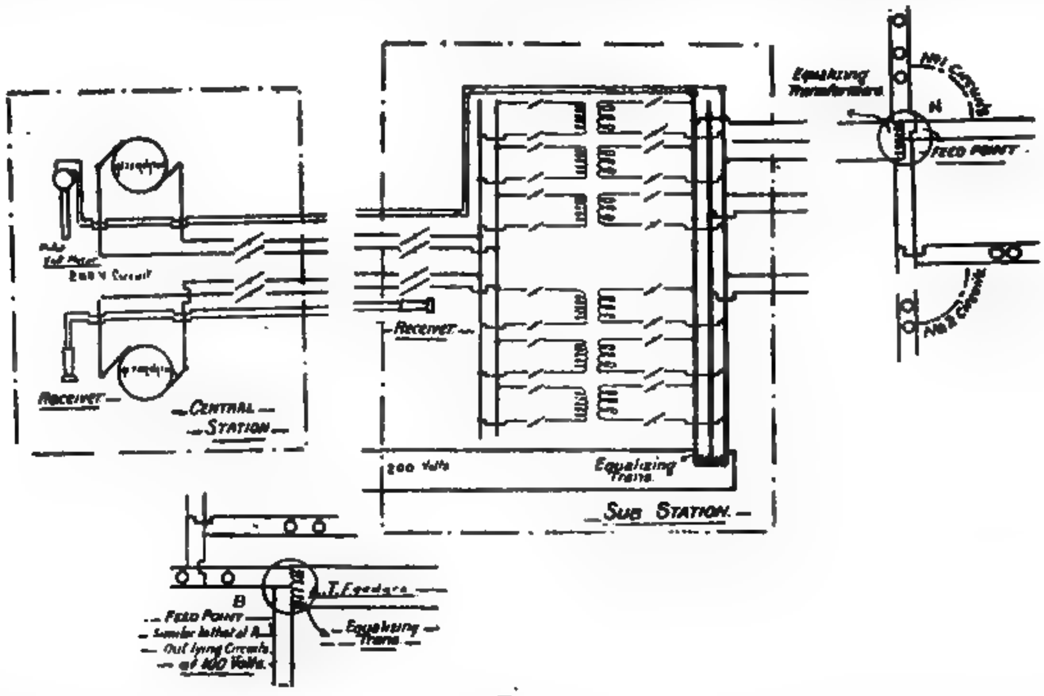


Fig. 1.

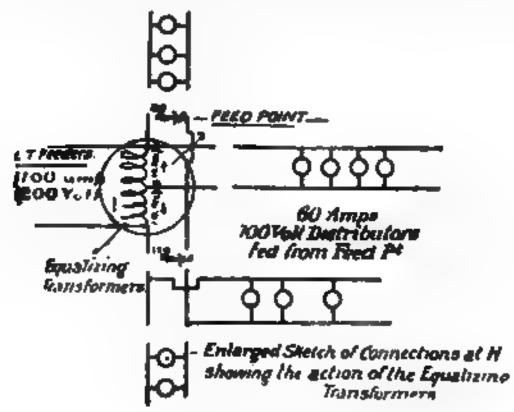


Fig. 1a.

The improvements relate to two parts of a distributing network. The first refers to low-tension mains, and is equally applicable to all kinds of distribution in which such mains are used. The second refers to distribution of alternating currents on the three-wire system—that is to say, to the *arrangements now* becoming common of causing the transformers at the sub-stations to give 200 volts and distributing the low-tension current on the three-wire system.

With regard to the first improvement, low-tension mains are at present laid either in the form of copper strips, which are placed in conduits and stretched, or in the form of insulated cables either laid in iron or earthenware pipes or buried in the ground. The introducers of this new system claim that great difficulties have been incurred by the copper-strip system, as the entrance of any water into the trench destroys the insulation, and the giving way of any of the tightening appliances causes the strips to slack and causes short circuits. They are further, when

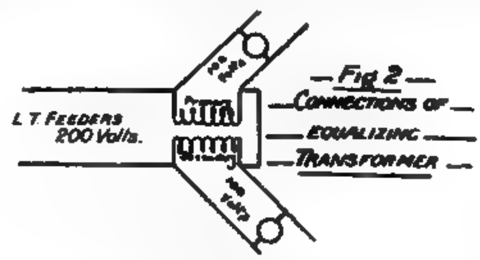


Fig. 2.

of a large size, not applicable to alternating-current distribution.

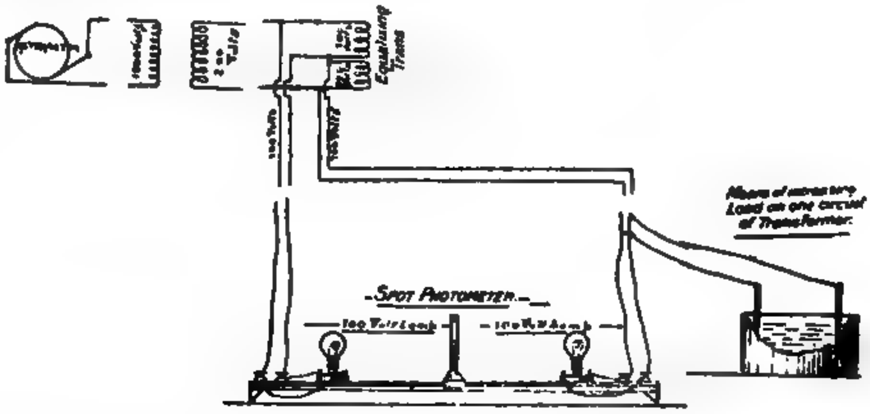


Fig. 3.

The system adopted by Messrs. Gordon is illustrated in Fig. 4, and in it the conductors consist of hollow copper tubes. These tubes are carried in porcelain insulators having the appearance of an ordinary nut or washer. They

are simply slipped on to the tubes and laid in concrete trenches. The trench is then filled up solid with an asphalte of a special composition, which is extremely cheap, and can be poured in nearly cold. The ends of the tubes open into the manhole boxes, and being hollow and presenting a large cooling surface, excessive heating is prevented.

Alternating currents, which, it is well known, travel only in the outside portions of large conductors, can be passed with full effect through the largest sized tubes used.

The stock sizes used by Messrs. Gordon are tubes having external diameter 2½in., 1½in., 1in., ¾in., and gauges from 9 to 19. Pilot wires or telephone wires can be drawn into the tubes if required, but are laid in the trench if laid at same time as the tubes, and in case the section of the conductor is at any future time not found sufficient a bare copper strand can be drawn in to reinforce it.

The important feature of the system, however, is the self-healing properties of the insulating arrangement. The first test of insulation resistance does not test quite so high as the highest class of cables, but it is practically impossible to injure it. In case of any fault occurring a little heat is developed at the fault, which at once melts the asphalte in the neighbourhood, but it then flows in and repairs the fault.

In the course of the experimental test recently undertaken by Messrs. Gordon, a piece of wet clay fell upon the asphalte before it was set, and gradually sank through it

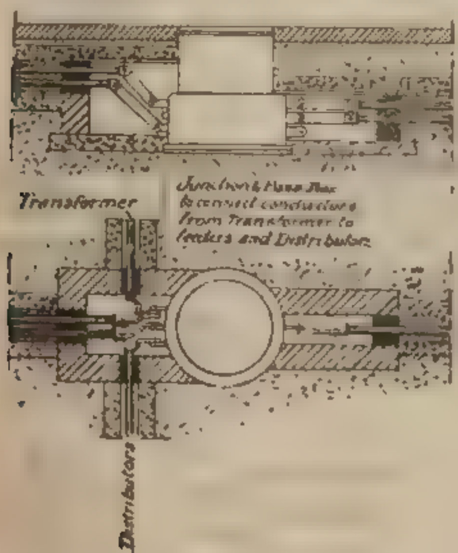


Fig. 4.

and formed a connection across the tubes. The insulation resistance at once fell very considerably, though not sufficiently to stop the use of the mains. Bubbles appeared for about three-quarters of an hour over the point where the clay had sunk in, and at the end of that period the insulation resistance rose to its full amount, and the main appeared to be in perfect order. On removing the clay afterwards, it was found to be baked hard and dry. It is intended to use this system at present solely for circuits not exceeding 200 volts, but Messrs. Gordon have an experimental length of it at Bray in practical work which has continuously 1,000 volts connected to it, and which remains in perfect order.

The cost of this system is said to be considerably less than the cost of the ordinary systems at present in use.

The second improvement—namely, the modification of the three-wire—is as follows: In the ordinary three-wire system a central wire has to be used throughout, which in itself is costly, and till recently, though we cannot quite say now, owing to the legal position of matters, a heavy royalty had to be paid to the owners of the patents. In case of a considerable difference of load between the two circuits, either the voltages become different or the loads have to be equalised by the use of a switching apparatus worked by hand.

In Messrs. Gordon's system the current at 200 volts is conveyed from the sub-stations by two wires only to the various feeding points. At each feeding point is placed an equalising transformer connected as shown in Fig. 3. The two sides of this transformer are equal, or, in other words, its ratio or transformation is 1 to 1. When the loads on the two circuits are equal, the transformer does not act, and there is no loss by transformation, but when the loads become different, current is at once automatically transformed from the circuit which is the least loaded to the circuit which is heaviest loaded, and the voltages of the two circuits are kept exactly equal. Fig. 1 shows the general arrangement of town mains laid in this manner.

Fig. 3 shows an experimental test of the system. A pair of circuits were connected and one lamp was placed upon each. These lamps were placed on the two sides of a grease-spot photometer, and adjusted for equality. A liquid resistance, consisting of two metal plates in dilute acid, was then connected to one circuit in parallel with the lamp, and the plates were gradually approached until they were brought

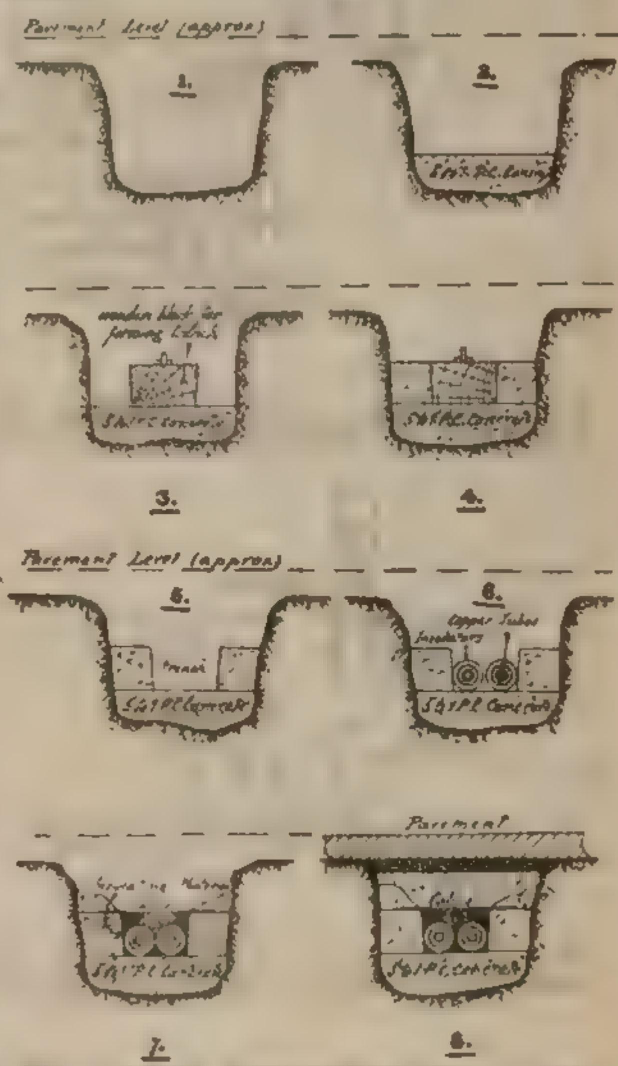


Fig. 5.—Section of Conduits, Showing Method of Laying.

into contact and the fuses melted. During the whole of this time, though the current on one circuit must have been at least 100 times the current on the other, no difference whatever could be detected on the photometer in the brightness of the two lamps. Fig. 5 (Nos. 1, 2, 3, 4, 5, 6, 7, and 8) shows sections of conduits and method of laying the mains.

HOVE.

The position of electric lighting in the Brighton district—where the Corporation and a private company are in competition—added a zest to the desire to know what was being done in the adjacent township of Hove. Upon receiving an invitation to be present at an "inauguration ceremony" at the Town Hall of Hove on Monday last, there seemed opened a way to get definite information as to the prospects at Hove. If a crowded room and an enthusiastic audience are evidences of future success, then the future of the Hove central station should be assured. It is not our intention

describe what is to be, because that in a great measure depends upon how generally the light is adopted. The outlook was referred to by various speakers and Lady Louisa Loder performed the ceremony of switching on the current. So far as we could gather, the meeting in the Town Hall, Hove, under the presidency of Mr. G. P. Woodruff, J.P., chairman of the Hove Commissioners, was intended to give information as to the present position and future prospects of the company.

The **President** said that after some years of serious thought and labour, they had met that day to inaugurate and formally open a very important section in their general system for the electric lighting of Hove. In this function they were assisted by a distinguished lady whom he would shortly invite to switch on the current. He gave a resumé of the action of the Commissioners in relation to the introduction of electricity in the town, and pointed out that the subject first engaged their attention in 1881, when what he characterised as a rather extraordinary scheme for the electric lighting of Hove came under their notice. It was at that period suggested that they should have what was known as tower lights on poles 200ft. high—"like miniature moons," humorously added the speaker, and the audience greatly appreciated this pleasant banter. Several proposals for the electric lighting of Hove were before the Commissioners in 1882, and application was made to the Board of Trade for their consent to a company being allowed to be established in the town for the purpose, but their consent was refused. In 1883, however, the Parliamentary Committee of the Commissioners recommended the Board to apply for powers to light the town, showing that even at that early time the Commissioners were alive to the importance of electric lighting. But proceedings, he explained, were difficult in consequence of a proposal on the part of the Board of Trade to issue a provisional order in some distinct form, and the matter was, therefore, "laid by" for the time being. Between the years 1886-9 renewed applications were made, and in 1890 their application was successful, and a provisional order was granted them. The Board, as a whole, had been of opinion that they should not undertake the electric lighting of the town at the expense of the ratepayers, and had, therefore, made a contract with experts, some of whom were on the platform, and he was happy to say that their experience so far had been highly satisfactory. "In the contract," continued the speaker, "we have guarded you as ratepayers in every way that is reasonable and proper. We have provisions as to the price, also as to discounts and as to the re-purchase of the undertaking after some years, and in other ways—in all ways, in fact—under the advice and assistance of the Board of Trade we have done all that is possible to protect you, and also to give this company to whom we have transferred our order all security, and I trust they will be able to make very good returns upon the capital. I am quite sure they will, because in three months they have laid down two and a half miles of mains in our streets in the most expeditious and in the most satisfactory way."

After a few remarks from **Mr. Woodman**, chairman of the Electric Lighting Committee,

Colonel Pilgate, as chairman of the Hove Electric Lighting Company, described the works. He explained that the company's plant would consist of two distinct portions—the generating station and the distribution system. Of these, the distribution system had been completed to the extent of about two miles out of the four miles required for the compulsory area, in a permanent manner, so that everything as now put down would remain in its present condition. The system of mains adopted was the one introduced by Messrs. Crompton and Co. in their various London contracts. It consisted of small culverts made of concrete, underneath the footways, in which the electric conductors made of bare copper were supported by porcelain insulators. There were movable covers to the culverts at distances of every fifteen yards, thus facilitating connections to houses and the drawing in of additional mains as might be required. The generating station was at present only in its temporary form. It would contain a generator more similar to those generally adopted in London. There would also be an accumulator-room containing sufficient storage in the shape of accumulators to perform the duty of acting as a reserve in case of sudden breakdown of the moving machinery, or of supplying the whole of the light required after 11 o'clock until four or five in the afternoon of the following day. This arrangement of supplementing the generating plant by storage batteries had the effect of making the light absolutely steady and free from those slight occasional jumps or flickers which were noticed whenever storage was not used. The contract for the whole of the works had been placed with Messrs. Crompton and Co., Limited, London and Chelmsford.

Lady Louisa Loder hereupon successfully switched on the current.

Mr. R. E. Crompton, in one of his characteristic speeches, assured the gathering that it was the desire of the electric lighting company to make the light popular by making it perfectly trustworthy and reliable. He spoke of the value of the current for domestic purposes and, characterising the price as the bugbear of the light, declared that in London the current did not cost more than gas. Hitherto the wealthy user had been a good friend to them, but in future the poorer user would be their best friend. He hoped there would be a universal demand for the light, the price of which, if it were more extensively used, would be materially decreased as time went on.

Mr. Dowsing gave a practical illustration of the many uses to which the electric current could be put for household purposes, and there was subsequently an exhibition of food cooked by electricity and tasted by many of those present, the work of the electric cookers while frying, grilling, boiling, and baking being watched with interest.

COMPANIES' MEETINGS.

SWAN UNITED ELECTRIC LIGHT COMPANY, LIMITED.

In the presence of a large number of shareholders, the tenth ordinary general meeting of this Company was held on Tuesday, at the Cannon-street Hotel, under the presidency of Mr. J. S. Forbes, the chairman of the Board. After the **Secretary** (Mr. H. C. Glover) had read the notice convening the meeting,

The **Chairman** moved the adoption of the report. In doing so he commenced with the profit and loss account. They would see, he remarked, that the sales, less commissions and allowances, amounted to £9,498, as against £15,348 in the corresponding year. At the first blush that was rather disturbing—that sales one year of £15,348 should diminish to £9,498 in the one following. It looked bad until it was explained. The fact was, they had a special order for 100,000 lamps for Australia at a very fair price, and the amount happened to come into the larger account. The lamps had been made from time to time and when they had occasion to sell them they did so. If they took the net price of those lamps—close upon £10,000—they would see that the sales of the lamps upon the local business was about £5,348. Bearing that in mind, the local business had this year increased from, say, over £5,000 to £9,498; in fact, it had nearly been doubled. In transfer fees there had been a slight diminution; people had apparently not been so anxious to transfer their interests in the Swan Company. The dividend on the shares in the French Company was £1,405 as against £1,178, that company having paid 5 per cent., as compared with 4 per cent. in the previous year. Competition was bringing prices down, but notwithstanding that he thought he might say that that company would this year show as good a dividend, and probably a larger one. The dividend on the shares in the Edison and Swan Company amounted to £37,094, as against £34,799, which was an increase. Of course, as they (the Swan United) had a very large share of their capital invested in the Edison and Swan Company, they participated in the improvement in their position. The stock, upon which depended the final adjustment of accounts, had been written down so as to render their position sounder in every respect, and that was the main cause of the diminution in the dividend. They proposed, as would be observed, to pay 1 per cent. less than in the corresponding year. The stock brought forward from last account was £18,449, and it had been reduced to £14,654. If they had left the stock at that value in the books they would have had about £3,800 more to divide. When he came to the question, he would tell them why they had thought it wise to reduce the value of the stock; that question would naturally arise when they came to the value. Coming to the debit side—purchases meant raw materials, although in some cases it referred to manufactured material, but chiefly raw materials which they worked up into lamps. The general charges, including all these variety of things—salaries, rents, directors' fees, law charges, etc., as set forth, amounted to £3,639. Then came wages and expenses at factory to £3,637, and sales ledger reserve to £200. The last item, he explained, was reserved to cover the risk of bad debts, because when the accounts were made up at the end of the year they found that that reserve fund was trenched upon to that amount. The purchases included the item of platinum, which had been a very errant quantity. They, both the Edison and Swan and the Swan Companies, were forewarned by competent judges that they would be wise to lay in a considerable stock of platinum, the output of which, chiefly in Russia, was very limited, and was mainly in the hands of a ring. Although largely used in electric lighting, he was somewhat surprised to find that the chief competitors of the electric lamp were American lamps. He could, however, not understand in the particular lamps in which they dealt, that continuity of life and indestructibility were so invaluable as in their lamps. However, the Company bought in advance a considerable quantity of platinum. In the Edison and Swan Company they were fortunate enough to utilise most of the material before a fall in the price of platinum set in, but that was not the case with the Swan Company. They had bought the material at an average price of 60s., and they could now buy it at about 30s. The price of platinum had fallen and advanced during several years, but they had considered it a prudent one, to write it down in the balance-sheet. Possibly by next year the rate at which they had written it down would be less than the market rate; then they could write it up. From the necessities of the business, they were obliged to retain large numbers of lamps in stock. In Germany they were compelled to keep a large variety of lamps which in each case amounted to no great sum, but in the aggregate reached a very considerable number. When they got up to 320,000 lamps, it implied a considerable amount of money locked up. They were face to face in Germany with severe competition in the lamp business, as they were also in France, and he supposed they would be in England sooner or later. They had therefore written the lamps down from 9d. to 8d., and 1d. on 320,000 lamps was an appreciable quantity. Well, these two matters and others of less importance accounted for what might have been brought forward, and which had led to the writing down of the stock to £14,654. They had thought it more prudent to do that than to declare 11 per cent. as they did last year. By following out this policy they had placed their balance-sheet on a sounder footing, and had brought it into line with the circumstances of the moment. In the production of a lamp platinum at 60s. meant 2½d., and at 30s. only 1¼d. The greater the quantity of lamps manufactured the less was the relative cost of production. In Germany, what was going on there at that moment was very

German indeed. There were in that country three companies who had resources and knowledge enough to carry on the lamp business. He supposed that he was not treading on false ground when he said that as far as they could ascertain, the lamp which they made in Germany was certainly as good, if not better, than those manufactured by their competitors. The first was the firm of Siemens and Halske, who made lamps by some arrangement with the Edison Company and on Edison's patents. Another great company was that which bought of Mr Edison for Europe the patents which they (the Swan United) purchased for Great Britain. The German Edison Company both made lamps and put up installations. Certainly a number of people had learned how to make lamps, and when they had got together a little money they started a lamp factory; but their only chance was to commence at impossible prices. Now these three companies had appreciated that position which they had not initiated, but had followed. They had determined to kill those small lampmakers, which was an idea unfamiliar to them in England. It would, however, result in the survival of the fittest, and the price of the lamp, which was now very low, might then be regulated so as to produce rather better results. That was their hope. That was what they had gone through during the last half year, and that was why their accounts and sales showed less favourable results than they might have if the prices had been equal to those of the corresponding year. Another feature, which was more or less problematical, was that in the depreciation in the price of the lamp, there was a possibility that the relative consumption would increase. If they paid 2s 6d for an article, they were likely to be more careful about the use of it than if they bought it for 1s 3d, and so with lamps. In the long run it did not matter whether they sold three lamps at 9d. or one at 2s 6d, because the profit was determined by the quantity they made. If they doubled their present quantity, they would probably produce the lamp at twopence less than the present price, and if they trebled their present output the cost of production would still be less. The matter turned exactly upon the number of lamps which could be divided into the fixed expenditure. He (Mr. Forbes) had received some letters from shareholders who expressed surprise at the reduction in the dividend. Although they paid less their position was really sounder. They had got to face the difference and as prudent men they had anticipated those sort of things. If they would again refer to the profit and loss account, they would see that the balance was £34,840 as against 39,000 in the corresponding period, that was about £4,000 less. This was mainly accounted for by the different evaluation of the stock. The next question was, what were they to do with the £34,840. They proposed to distribute it, retaining a reasonable reserve. They would see from the balance sheet that the Company had brought down a balance from the previous account of £8,010. The reason for having carried forward so large an amount was because the Directors foresaw then the question of prices, and that rectification of the balance sheet was imminent, and they had therefore considered it prudent to bring that forward from the previous year. They had already distributed for the first half year an interim dividend amounting to £14,558, and they now proposed to distribute a further sum at the rate of 12 per cent. for the half year. This would make the yearly dividend at the rate of 10 per cent., and enable them to carry forward about £6,000. The share capital stood exactly as it had during several years, namely, £375,071. There was one item in the balance sheet which had disappeared, namely, £3,885 in forfeited shares, which had been brought forward from time to time on one side of the account as a debt. It was no use bringing forward shares which had been forfeited. The money represented on the shares belonged to the Company, and instead of carrying forward an item which was likely to mislead, it had been thought better to knock it out of the accounts altogether. They had now written down the patent rights to £328,503. With regard to factory plant, they had got a portion of a large factory in Germany with certain standing machinery, but in order to make that factory efficient to turn out their commodity they had had to spend from £10,000 to £12,000. That money had, however, been written down to £1,570. Mr Forbes then mentioned the New and Prussian Consols, stock, cash on deposit and in hand, and observed that that was the whole story, which he could not enlarge upon, but having gone so far, he would proceed to paragraphs in the report. The first paragraph concurred with all that he had said in detail. "The profit and loss account for the year shows a credit balance of £34,840 11s 11d., which, together with £8,010 3s brought forward from the last account, makes disposable the sum of £42,850. 15s. 0d. An interim dividend in respect to the first half of the year, amounting to £14,558 9s 8d., has already been paid. The Board proposes that a further sum of £21,467 8s 4d be divided, free of income tax, and that £6,824 17s 9d be carried forward." They had, he said, rather a peculiar distribution. It was very puzzling and involved enormous calculation, and really after all there was nothing in it. They had two classes of shareholders, partly paid and otherwise. "The distribution of this amount in accordance with clause 77 of the articles of association will work out at 4s 2½d per share on the 78,949 ordinary shares of the Company, £3. 10s paid, and at 4s 11¼d per share on the 19,750 £5 fully paid, being equivalent to 10 per cent. per annum on the partly paid and of slightly under that rate upon the fully paid shares. The dividend will be paid upon the register as it stood upon November 15, and the warrants will be issued on December 13." The litigation over the patents in Germany had fortunately come to an end. As long as they were in litigation in Germany, they laboured under the disadvantage of not knowing where they were. They could not push their trade because the German law was rather peculiar on the subject of damages. Until one got a decision of the court, one did not know where one was. There was first the validity, and, secondly, the damages. How much would one be mulcted in? As prudent men, with the case before them, they did not push the trade, but made the best of the matter. Of course, they no doubt made some sort of provision that the question of damages might turn out awkward some day. However, they were not infringers, and they were left to proceed. That enabled them to push the business without the shadow of fear hanging over them. The Swan United had got some £30,000 invested in the French Edison Company, which had been made an Edison and Swan Company. That company paid 5 per cent. last year, and showed a possibility of future value. Their partners there were the people who had the putting up of installations in large parts of Paris, etc., and they were getting a good price. Their agreement precluded the Swan, and indeed the Edison and Swan, from travelling on the Continent, with the exception of in Germany. Mr Forbes did not admire the principle of compulsory service in that country, although he was bound to admit that the workmen were thereby more disciplined, and that enabled them to deal with workmen on more reasonable terms than those not so trained. It all amounted to this: they would be able to turn out the lamps in Germany scientifically as perfect, mechanically as perfect, and at less cost, he fancied, than either in France or in Great Britain. That was a very important lever for them. For some time they had supplied their French friends with lamps made in London, they could now furnish them with lamps manufactured in Germany at a great deal less than in Paris. Paris had, however, a kind of London Trades Council which regulated the prices of wages, but in Germany they were not encumbered with such an institution. If they could induce their French neighbours to take lamps from Germany, that company would pay more than 5 per cent., but they would not do so. The Swan United was allied here because a large portion of their capital was invested in the Edison and Swan Company. They had a portion of it safe in the French Company, and they had the German residuum. This it was proposed to amalgamate with the British Edison and Swan Company. As mentioned in the report "the Board believed that the time has arrived when a fusion of the residuum of the foreign business of the Swan Company with the British Edison and Swan Company may be effected with advantage to both interests, and negotiations are pending with a view to effecting some arrangement in this direction." Mr Forbes observed that he was the happy man who held the balance between two interests. The fusion ought to be effected both as an economic and as a defensive measure, as that would make both companies richer and stronger. Mr Quilter and Mr Swan on this side and the Earl of Lichfield and Sir John Lubbock on the other should be able to think the matter out properly. Some arrangement might be made under which the Swan Company should be merged into the Edison and Swan Company. The negotiations on this matter were pending, and the only question now lay in the figure. The theory was that the Edison and Swan Company should purchase that residuum of the Swan Company at a price, with a commodity to be called debenture stock bearing some reasonable rate of interest. He only mentioned the matter on that occasion so that the proprietors might know that there was something pending which was greatly in the interests of the Company. A special meeting would, of course, have to be called of both companies, and it would be for them either to accept or reject the proposition. Mr Forbes then referred to the great loss to the Company in the death of the late Mr Leyland, deputy-chairman, who had been succeeded by Major Flood Page. If the two English companies were amalgamated, there would be no necessity for the present Board, and there would be a saving of £2,500 a year. He then moved the adoption of the report and accounts.

Mr W Cuthbert Quilter seconded the motion.

Mr Skipworth did not regard the balance sheet as satisfactory. It seemed to him that they were carrying on their factory at a loss. He was glad to hear that some progress had been made towards the fusion of the two companies, but Mr Forbes had said the same thing last year. It appeared to him that the negotiations should not occupy a period of a year or 18 months. He would be glad to hear whether they were approaching a conclusion in the matter.

Mr Forbes, who had already answered these questions in his remarks, repeated them.

The motion was then put to the meeting and was unanimously adopted.

The **Chairman** then proposed: "That in addition to the £14,558 9s 8d already distributed in respect of the six months ended March 31, 1892, a further sum of £21,467 8s 4d be divided, free of income tax; to be distributed in accordance with the provisions of clause 77 of the articles of association, making a total distribution for the year of £36,025 18s." The distribution of the amount £21,467 8s. 4d., in accordance with clause 77 of the articles of association, will work out as follows: on the 78,949 shares, £3 10s paid, 4s 2½d per share; on the 19,750 shares, £5 fully paid, 4s 11¼d per share; being, with the interim dividend previously paid, equivalent to 10 per cent. per annum on the shares £3 10s paid, and of 8⅞ per cent. per annum upon the shares £5 fully paid.

This resolution was also seconded by **Mr Quilter**, and was carried.

Mr Forbes and Mr Batt, the retiring directors, were then re-elected, as were also Messrs. Welton, Jones, and Co., the auditors. This brought the general business of the meeting to an end, after which **Mr Forbes** made some lively comments on a letter which he had received from a shareholder.

A vote of thanks to the Chairman and Directors concluded the proceedings.

INTERNATIONAL OKONITE COMPANY.

Mr Alexander Armstrong presided on Wednesday at the Cannon-street Hotel, at the annual general meeting of this Company. A letter, however, was read at the outset of the proceedings from Mr. Samuel Pope, Q.C. (the chairman of the Company), stating, among other things, that the Manchester factory absolutely required an immediate reorganisation of its administration, and suggesting the adjournment of the meeting.

The Chairman accordingly moved its adjournment until January 10, stating that they would then have an ample opportunity of considering the balance sheet, and Mr Pope would then be in a position to give them a better explanation of their affairs than he himself could.

The motion was seconded by **Mr. J. H. Todd**, but was strongly opposed by several of the shareholders.

Ultimately, however, it was agreed to.

NEW COMPANIES REGISTERED.

L. Alwyn, Limited.—Registered by E. G. Van Tromp, 16, Essex street, Strand, W.C., with a capital of £2,000 in £1 shares. Object: to carry on the business of electricians and electrical engineers in all its branches, and as agents for the Brush Electrical Engineering Company, Limited. Registered without articles of association.

R. C. Cutting, Douglass, and Co., Limited.—Registered by J. D. B. Lewis, 20, Bucklersbury, E.C., with a capital of £10,000 in £5 shares. Object: to acquire as a going concern the business of lightning conductor manufacturers and electrical engineers now carried on by R. C. Cutting, Douglass, and Co., Limited, and to carry on and extend the same in all its branches. With slight modifications, the regulations contained in Table A apply.

Electrical and General Contract Corporation, Limited.—Registered by Clarence Leighton, 12 and 13, Clement's inn, Strand, with a capital of £50,000 in £6 shares. Object: to enter into, or acquire by purchase or otherwise, and carry out, contracts and concessions or other grants in any part of the world, for making, purchasing, or working railways, tramways, telegraphs and telephone lines, electric and other lighting, electric, hydraulic, and other works, and for the equipment of any such undertakings with electric or other plant, stock, or apparatus, etc. The first signatories are:

	Shares.
J. F. Mieville, 12, Angel court, E.C.	1
W. S. G. Baker, 35, Parliament street, S.W.	1
A. de Turckheim, 135, Parliament street, S.W.	1
H. Chestermaster, Jeffrey square, E.C.	1
D. Parrish, 2, Copthall buildings, E.C.	1
G. E. Church, Dashwood House, E.C.	1
F. Manelli, 101, Leadenhall street, E.C.	1

There shall not be less than two nor more than seven directors. The first are W. S. Graff Baker and Alfred de Turckheim. Qualification, £100. Remuneration, £100 each per annum.

Sir James Farmer and Sons, Limited.—Registered by Last and Sons, 19, Pall-mall, S.W., with a capital of £50,000 in £10 shares. Object: To acquire and undertake the whole or any part of the business of the firm of Sir James Farmer and Sons, engineers, Salford, Manchester; generally, to carry on the businesses of machinists, mechanical and electrical engineers, machine and tool makers, boiler-makers, etc., in all their respective branches. The first signatories are:

	Shares.
A. W. Farmer, Adelphi Iron Works, Salford, Lancashire	1
J. S. Farmer, Adelphi Iron Works, Salford, Lancashire	1
M. Watts, Victoria park, Manchester	1
J. H. Storey, Lancaster	1
S. Watts, Victoria park, Manchester	1
C. A. Farmer, Adelphi Iron Works, Salford	1
G. P. Watts, Brook House, Levenshulme	1

There shall not be less than four nor more than seven directors. Qualification: One share. Most of the regulations contained in Table A apply.

BUSINESS NOTES.

Stockholm.—An electric tramway is to be established at Stockholm.

Budapest.—A company has been formed to run the Budapest electric tramways.

Brussels.—Tenders will shortly be required for lighting the Brussels Hotel de Ville.

Coal-Getting.—The North Hungarian Coal Company are installing electric coal cutters by Messrs. Ganz and Co.

Antwerp Electric Railway.—The scheme for an electric railway between Antwerp and Brussels has been set aside.

Siemens and Halske, of America.—The *Electrical World's* Chicago correspondent sends an interesting account of the progress of this firm, who are building motors of 1,000 h.p.

Scarborough.—The idea of the immediate introduction of electric light is being received with much enthusiasm in Scarborough.

Thomson European Welding.—A meeting of shareholders of the Electric Welding Company has been called by a banking house in New York.

Andaman Cable.—The question of connecting Port Blair with the Andaman Islands has been shelved by the Indian Government on account of the expense.

Harwich.—The Corporation of Harwich in another column advertise their desire to have tenders for the purchase or hire of their electric lighting powers.

Bath Asylum.—The new Bath and County Asylum at Bishop's Lydeard, near Taunton, is estimated to cost £140,546, of which £2,500 is for electric lighting.

Underground Wires.—At Bournemouth, Councillor Hankinson will move at the next meeting of the Town Council that all telephone wires should be placed underground.

Penmaenmawr.—At the last meeting of the Local Board the clerk was instructed to write to Dolgelly for information as to the comparative cost of gas and the electric light.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino-Brazilian Company, were £3,079.

Milan.—A scheme is approved for the establishment of an overhead conductor system of electric tramways at Milan by the Societa Edison. The water power at Paderno will be utilised.

Push-Button Switch.—Mr George Cutter has brought out in America, a push button switch, a light touch being sufficient to turn on or off the light. The same kind of action is also attained with a pull cord.

Simla.—It is feared that the project for the electric lighting of Simla will have to be abandoned on account of the expense. Perhaps if a less expensive firm had the contract in hand the proposal might yet be saved.

Teignmouth.—A requisition has been presented to the Teignmouth Local Board by the ratepayers to call a public meeting to discuss the extension of the gas works or the installation of a central electric station in the town.

Chairman.—Mr J. B. Braithwaite, jun., having been elected chairman of the Brush Electrical Engineering Company, Limited, in succession to the late Duke of Marlborough, has accepted the appointment for the period of one year.

Ledbury.—Mr J. C. Davies, of Fair Tree Farm and Brick Works, has the honour of being the first to introduce the electric light into the neighbourhood. The works and dwelling house are both lighted from an engine used at the works.

Belfast.—Tenders are invited for the electric lighting of Queen's Quay, Abercorn Basin, and the Hamilton Graving Dock, by the Belfast Harbour Commissioners. Tenders by 5th December to Mr. W. A. Currie, secretary, Harbour Office, Belfast.

Newark.—A proposal is made to light the Newark Town Hall with gas, but this it is thought by others, should be left over till the receipt of the Electric Lighting Committee's report, which may recommend an immediate introduction of electric light.

Brazilian Submarine Telegraph Company, Limited.—The Directors of this Company have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, tax free, for the quarter ended September 30, payable on December 21.

Larne.—The Larne Commissioners are not altogether satisfied with the light they have been receiving and have written to the contractors to state that they will deduct for light when not received. A recent failure was, we learn, due to bad cables.

Santiago.—Tenders are invited until March 1, 1893, for the electric lighting of Santiago, Chili. A specification, and a plan of Santiago, can be inspected, on personal application, at the Commercial Department of the Foreign Office, on any week day between 11 and 6.

City and South London Railway Company.—The receipts for the week ending November 27 were £503, against £[illegible] for the corresponding period of last year, or an increase of £[illegible]. The total receipts for 1892 show an increase of £1,727 over those for the corresponding period of 1891.

Warminster.—At the monthly meeting of the Local Board the chairman stated that his gift of a drinking fountain would reach Warminster in a fortnight's time, and it was decided to try both the arc and incandescent electric lamps before deciding which of the two should be erected over the fountain.

Buxton.—At the meeting of the Buxton Local Board the chairman stated with reference to the electric lighting question, that no notices had been given, and neither the Board nor anyone else could obtain powers; consequently it had been considered best to drop the question for 12 months to consider it.

Liverpool University Clock.—A large clock, with dials 11ft. in diameter, has been presented to the city of Liverpool. The clock also drives three large dials inside the building by an electrical arrangement attached to the clock works. The whole were supplied and fixed by Messrs. Wm. Potts and Sons, Leeds.

Extension of the Electric Railway.—The City and South London Electric Railway Company have given formal notice to the Lambeth Vestry of their intention to begin the construction of

their extended line from the present terminus at Stockwell to Clapham Common, under the powers obtained by them under the Act of 1890.

Edison Swan Offices.—Great interest is manifested by passers in the City at the magnificent show made by the Edison Swan Company at their new City offices at 110 Cannon-street. The large windows are filled with all varieties of incandescent lamps, many of them ablaze with light and colour, the whole making a most attractive show.

Cheap Lamps.—Circulars from continental lampmakers show that lamps are now sold to fit any socket in lots of thousands at 1f each, free on board any European port. They are being sent to America, and with duty 45 per cent. and freight charges, they still only come to 1s 3d. each, 100 per cent cheaper than the cheapest American lamp.

Belfast.—At the meeting of the Belfast Gas Committee last week, it was reported that Prof. Alexander B. W. Kennedy, F.R.S., 19, Little Queen street, Westminster, London, had been appointed consulting electrical engineer to the Belfast Corporation. The site of the first electrical works will, it is understood, be on the banks of the Lagan, off Laganbank-road.

Bromley.—A movement in the direction of electric lighting is being made in Bromley, the Board having asked those willing to take up the new light to fill up forms intimating the extent of their requirements. According to the official estimate, the Board put the cost of the electric light at 32s 6d. per annum plus the hire and maintenance of the meter and other appliances.

Swindon.—In our advertisement columns will be found a notice by the Swindon New Town Local Board inviting tenders for lighting the public streets by electricity or otherwise, for one year commencing on January 1, 1893. Tenders are to be sent in by the 12th day of December. This will allow about a fortnight to start. A good feeling towards electric light exists in influential quarters in the town.

Personal.—We understand that Mr. Alfred Slatter, A.I.E.E., has retired from the Planet Electrical Engineering Company, and, besides several consulting appointments, has joined the firm of Messrs. Julius Sax and Co., of Central Markets, Smithfield, E.C., and Ridgmount street, W.C., as their manager. Mr. E. J. Tumber has resigned the position of general manager to the Electric Stores, Limited.

Kingston.—At a special meeting of the Kingston on Thames Town Council last week, it was resolved to introduce electric lighting into the borough, and to communicate this decision to the Surrey County Council, in order that arrangements may be made for the electric lighting of the new county buildings when completed. Mr. W. H. Preece has been asked by the Town Council to report.

Auction Sale.—An important sale by auction is announced by Messrs. Wheatley Kirk, Price, and Goulty, of engineering and electrical plant and machinery, dynamos, motors, gas engines, and other material, at the East Down Electrical Works, Lewisham. The materials, which were used in a regular electrical manufacturing and contracting business, comprise some eminently practical pieces of machinery. The day of sale is December 13.

Blackpool Tower.—The construction of the great Blackpool Tower is now progressing fast. The four legs have all been put down, and the main and gallery girders fixed, and by next week the next section, which advances another 85ft., will be commenced. Large arc lights have been erected upon the site of the tower, and at night a current from the dynamos at the Aquarium provides a brilliant light, by the aid of which the work is carried on in overtime.

Commercial Cable Offices.—The Commercial Cable Company have opened a branch office in East India-avenue, Leadenhall street, from which messages are sent direct to the cable ends. The Commercial Cable Company connects with the Postal Telegraph Company of America, reaching all important places in the United States; with the Canadian Pacific Telegraphs throughout Canada; with Bermuda, the West Indies, and Central and South America.

Electric Fire Bells for Bournemouth.—The report of the captain of the Bournemouth Fire Brigade, in which he recommended the Council to adopt the system of electric fire bells in addition to the present telephones, and also that the Council should keep horses suitable for drawing fire engines, was read at the meeting of the Lighting Committee. The report was referred to the surveyor for him to confer with the captain of the fire brigade, and report more in detail.

Edinburgh.—At the meeting on Monday of Edinburgh Town Council, the Lord Provost impressed upon the members the fact that one half of the three years' period for which the electric lighting provisional order endured had already elapsed, and suggested that something should now be done as to enquiring into the best systems of lighting in vogue. After some conversation, it was agreed that at next meeting a deputation should be appointed to visit different towns and acquire information.

Chatham.—At the meeting of the Chatham Town Council last week, it was moved and carried that notice be forthwith given to the Chatham, etc., Electric Lighting Company as follows: "That all roadways and footpaths broken up for the company's purposes, and which they have failed sufficiently to restore within three weeks after being broken up, will be taken in hand by the Corporation and completed at the expense of the company, unless the said roads and footpaths be duly reinstated within seven days after notice."

Incandescent Gas Lights.—It was recently stated in a lecture given by Prof. P. B. Lewes, the well known gas expert, that to obtain a light of 48 c.p. for 2,000 hours by the incandescent gas light system, would cost 30s. (with gas at 3s. per 1,000ft.), including renewals, while by the incandescent electric light the cost would be 245s., or more than eight times the amount. The problem as stated may be worth the attention of the calculating powers of those on the other side of the question.

Fire Risks.—That there has been rather unnecessary ardour on the part of the fire insurance officials to swell the list of accidents by electric light is the opinion of the *Financial News*. Many of the instances do not seem to be authenticated to the point that is properly required in such a schedule. Comparative immunity from accidents by fire is one of the strong points of the electric light, and if it is to be robbed of this prestige, maintains our financial contemporary, it should be on the best evidence.

Proposed Victoria-Kilburn Electric Railway.—During the ensuing session of Parliament a Bill is to be promoted with the object of incorporating a company for the purpose of constructing an underground electric railway from a point on the Vauxhall Bridge road side of the Victoria railway station, and passing from thence under Edgware road to Kilburn. The gauge which it is proposed to adopt on this line will be the ordinary standard gauge adopted on all passenger railways of 4ft. 8½in., thus differing from several of the electric railway schemes already authorised or projected.

Ceylon.—The Eastern Produce and Estates Company, as agents for Messrs. Gilkes and Co., are open to erect electrical installations to transmit power derivable from water three miles or less from its source. This, says the *Ceylon Express*, opens up wide possibilities for many groups of estates in possession of the necessary water power, as several estates in the higher districts are. But, unless a number could combine together to secure power transmitted from water, the cost would be very high, judging by the table of rates submitted by the manager of the company above referred to.

Aberdeen.—The Gas Committee of the Town Council met on Wednesday—Mr. Farquhar, convener—and considered the question of electric lighting. A correspondence with Prof. Kennedy, Glasgow, was read, to the effect that his charge for superintending the work would be at the rate of 3½ per cent. on the plant laid down and £100 to cover his expenses. Prof. Kennedy is to prepare plans for the interior of the building where the plant is to be laid down, and on that work he will charge 2 per cent. The terms were accepted, and instructions given to get specifications prepared forthwith.

Electric Tramway for Lytham.—Notices have been posted along the route of the proposed tramway between Lytham and Blackpool, to the effect that the company intend applying to Parliament during next session for power to construct the line. The line will traverse the streets of Lytham to St. Annes, and thence to Blackpool. It will pass the new watering place, Fairhaven. Last year application was made to the Board of Trade for a provisional order, but it was withdrawn, as the Corporation of Blackpool opposed the scheme very strongly. It is now thought that no opposition will be given.

Hull.—It is expected that the electric lighting station at Hull will be completed about Christmas. The committee appointed to carry out the details in connection with the opening ceremony have determined to give the local installation contractors, most of whom are agents for the large electrical firms, the opportunity of exhibiting electrical appliances. The exhibition will be held in the Sessions Court, and it will probably be open to the public for five days. The object is to give the public the opportunity of gaining information and witnessing the advantages of electricity. Messrs. Crompton have arranged to give an exhibition of cooking by electricity.

Comparative Cost of Gas and Electricity.—Mr. C. J. Russell Humphreys in the American *Engineering Magazine* has an article on "The Relative Cost of Gas and Electricity." From the American standpoint, he concludes that to obtain the unit of light we require 40 per cent. more capital for electric light than for gas, and that the cost of producing this unit of light will be for electricity 20 per cent. more than by gas. An improvement will be made by using large dynamos, direct coupled, with triple-expansion engines, remembering also that gas can also be improved. Coal is wasted fearfully in both processes, and great rewards await those who reduce this waste and enable us better to utilise that precious possession—coal.

Brighton Electric Railway Proposal.—A Bill for powers to construct an electric railway from Brighton to Rottingdean, we understand, is to be introduced into Parliament next session. This railway, which will be nearly four miles in length, will commence near Paston place, Brighton, and proceed along the beach and foreshore "between high and low water mark at a distance of about 100 yards from the cliff" to Rottingdean. From the termination of the railway a jetty is proposed to be constructed for a distance of 200ft. into the sea. The railway will be constructed on the extraordinary "gauge" of 24ft., and provision will be made for the construction of the platforms at such an elevation as to be safe from interruption by the sea.

Dundee Town House.—At a meeting of the Dundee Property Committee of the Town Council last week, ex-Bailie Keith suggested that the Town Council should be among the first to patronise

the electric light, and he proposed that the city architect should take in contracts for supplying the Town Hall, the [illegible] Hall, and the whole of the offices with the new illuminant. The hope was expressed by some members that it would not be necessary to remove the fine crystal gasaliers from the Town Hall, and Mr Keith said that would be for the consideration of the architect, but in his own opinion, he thought it would be possible to run a wire along the stems of the gasaliers and substitute electric jets for the gas burners. The architect was instructed to forthwith arrange for obtaining offers for the work.

Twickenham.—The Lighting Committee of the Twickenham Local Board are occupying their attention with the desirability of introducing the electric light. The district is rather scattered, and an alternating current system would probably be preferable. A representative of Messrs. Hammond and Co. attended the last meeting of the committee, and explained a proposal for lighting the parish. His offer to submit an estimate without charge was accepted by the committee. We should advise this committee without further delay if they intend to introduce the light, not to potter with free estimates, which must necessarily be partial, but to engage the services of an independent consulting engineer, have the project fully discussed, and proper specifications and plans obtained, which should be publicly tendered for in the usual way.

Weston-super-Mare.—A special meeting of the Weston Local Board was held last week to consider the electric lighting question. The special point was whether the Board should carry out their provisional order, or should delegate the matter to a private company. To carry out the complete scheme, it was stated would involve an expenditure of £30,000, but not more than half would be required for present expenditure. The Board expended for public lighting last year £1,643, which would offer a fair return on the proposed expenditure. It would be a guarantee of more than 5 per cent. on £30,000 and if borrowed publicly would be sufficient to establish a sinking fund to extinguish the debt in 30 years. The example of Scarborough is quoted on the side of founding a company, but it does not appear that any definite resolve has yet been made.

Liverpool Town Hall.—The Finance Committee, at their meeting last week, decided to have the electric light installed in the large ballroom and the Council-chamber at the Town Hall. The cost will be about £360, of which £155 will be expended in the illumination of the large ballroom, £45 will be paid for cable, providing for the extension of the electric light throughout the building should the present experiment be a success, and £160 will be the outlay on the Council chamber, this sum including the cost of the fittings, which will be of an ornamental character. The gasaliers in the ballroom are to be taken down, cleaned, and repaired, on the completion of which work the electric light will be introduced into each. Arrangements are to be made to connect the mains of the Liverpool Electric Supply Company as soon as possible, so that the light may be used for the present season.

Western Telephones.—Mr. F. Dagger has resigned his position as superintendent of the Plymouth district of the National Telephone Company, and his connection with the company will cease on the 28th inst. Mr. Dagger entered the telephone service 11 years ago, having served four years with the Lancashire and Cheshire Telephone Company, in North East Lancashire, four years with the Western Counties and South Wales Telephone Company, at their head offices in Bristol, and three years as superintendent of the Plymouth district. While at Plymouth, Mr. Dagger has had exceptional difficulties to contend with, more particularly with the severe storms, including the well remembered blizzard, and on these occasions his skill and energy have been of utmost service. He leaves the company having aided during the last three years in the establishment of a greatly improved telephone service.

Huddersfield.—At the recent annual meeting of the Huddersfield County Council, with reference to electric lighting in the official statement for the year, the Mayor stated that the Local Government Board gave their sanction to the borrowing of £50,000 in May last, and the Council were then able to enter into the following contracts and commence work: For the buildings, machinery foundations, chimney, and flue, £8,348; for the generating plant, which will be capable of supplying the energy for 4,000 16-c.p. incandescent lamps, including underground mains, transformers, and controlling apparatus, £20,640; for the 10in. cast-iron pipes for carrying the water required for condensing from the canal to the electric supply station and back to the canal, £406—making a total of £29,394. It was hoped that the electric supply would be commenced in the spring of the coming year.

Nottingham.—The Electric Lighting Committee of the Nottingham Town Council have prepared a report which will be presented to the Council next Monday. It embodies a full and lengthy report from their engineer, Mr. H. Talbot. The estimate of cost is land in Wollaton-street, £10,175; buildings, plant, and mains £34,580; total, £44,755. The committee strongly recommend that the site be purchased and the necessary plans and specifications put in hand, and as soon as consent of the Board of Trade is obtained that tenders should be invited. The system to be adopted is low pressure continuous three-wire distribution in conjunction with high pressure continuous current and motor transformers, the station to be for 15,000 8-c.p. lamps, plant for 10,000 8-c.p. to be first put down. The dynamos are to be specified at "so much water used per electrical horse-power at the terminals." Batteries for 1,000 8-c.p. lamps would be installed.

Heckmondwike.—At last week's meeting of the Heckmondwike Local Board, the Electric Lighting Committee's minutes were read and approved. They authorised a visit to view the installation at Morecambe, and to ascertain from the town clerk of [illegible] borough the terms upon which his Corporation had arranged to transfer their power to light the borough with electricity to a private lighting company. Mr. Redfern remarked that the committee did not appear to be making much progress with the scheme, and impressed upon them the necessity of making a report to the Board one way or the other as soon as possible. The Wholesale Co-operative Society would require the 500 lights which they had promised to take for their Heckmondwike shoe works by next September, or they would take steps to adopt an installation of their own. If the Board intended to go on with the work, it should be done at once, or it would be no use troubling any more about it. Mr. S. Wood (the chairman of the committee) replied that the committee were expediting the matter all they could and would soon be able to submit a report to the Board.

The Rhondda Valley.—In the localities of Cwmdare and Cwmpare, situate in the upper part of the Rhondda, where the Ocean Colliery Company have two large collieries, there have been hundreds of workmen's cottages lighted by electricity in the evening and morning for the past few months. The [illegible] generating the electric current is situated in the fan engine-house at the Dare Colliery, using the motive power of the fan engine. On Sunday evening the Independent and the Methodist chapels were lighted by the plant at the colliery, and the [illegible] gave absolute satisfaction. Since the chapels were opened [illegible] years ago they were lighted in the evening with oil, there being no gas mains in the district. Mr. Williams, electrician at the Ocean Collieries, informed the members of the chapels that the places of worship could be very well lighted by the electric current from the collieries at a cost not exceeding [illegible] annually, so the oil lamps were replaced by electric incandescent lamps, numbering about 25 in each chapel. The innovation caused considerable curiosity in the localities, and hundreds [illegible] place to see the light in the chapels. The members of the [illegible] chapel in the district have decided to have their place of worship lighted by electricity, and the oil lamps will be abandoned.

London Mains.—The Highways Committee of the London County Council, at their meeting on Tuesday, reported that they had considered a notice, dated 12th November, 1892, from the House to House Electric Light Supply Company, of intention to lay mains along two sides of Hereford-square. These mains will be laid in 3in. cast-iron pipes, and the proposed works appear to be unobjectionable. They recommend that the sanction of the Council be given to the works referred to, upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works in any of the streets referred to in the notice; that no pipes of a larger diameter than [illegible] be used; that the street boxes shall be of the pattern approved by the Council, and that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover shall be efficiently connected to earth. The Kensington and Knightsbridge Electric Lighting Company has also given a notice, dated November 1892, of two short extensions of mains in Cromwell-road. The committee recommend that the sanction of the Council be given to the works referred to. The St. James and Pall Mall Electric Light Company has given an emergency notice, dated November 22, 1892, of its intention to substitute insulated cables for the existing bare copper conductor mains in Pall-mall, from [illegible] street to 6, St. James's-street. The alteration, which is very desirable, should be made in all cases as quickly as possible and the committee are of opinion that the company is justified in treating the matter as one of emergency.

Llandudno.—A proposal is being brought forward in Llandudno by Mr. W. Kingsland, A.I.E.E., for an electric railway along the Parade, on the spare space between the asphalte and the [illegible]. It is proposed to have a small station for generating the current by means of a gas engine and a dynamo machine, which would be put out of the way somewhere at the back, about Craigydon. The current would be conveyed underground to the trams, and by means of suitable connections be applied to the car as it moves along the rails. The current would be used at such a pressure that no shock could be received, even if the bare conductors were freely handled. It is proposed, in return for the concession to run the line, to light the Parade with electric arc lamps all the year round; with regard to the desirability of which there would be hardly two opinions. Of course the cars would be run during the winter as well as in summer, though necessarily not so frequently. This will doubtless add to the attractions of the place as a winter resort, besides being of the greatest service to residents at Craigydon, Little Orme, and Penrhynside. The facilities which the line will offer to residents and visitors at these places all the year round will, it is thought, be a very great consideration in its favour. The line will be single, with a crossing place at the middle, so that there will be two cars running on the line, starting simultaneously at each end, and passing each other in the middle. The speed will be about six miles per hour. A return ticket for the whole distance would be issued at 3d., or 2d. for the single journey, and 1d. for [illegible]. The cars would stop to take up or set down passengers at any point. One of the principal objections which is sure to be brought forward in connection with this scheme is anticipated by Mr. Kingsland. It is with regard to the danger to children and

others in crossing the line. Being anxious to know on authority what had been the experience at Brighton, he wrote to Mr. Magnus Volk, the proprietor In his reply Mr Volk says: "During nearly 10 years (10 summers, anyway) we have never injured one of our passengers in any way, we have never touched a child, and merely bumped one foot passenger, who, to avoid a perambulator, suddenly stepped against one of our cars." Mr Kingsland is right in anticipation of this objection, for a ratepayer writes to say he is sure any Board would be turned out which proposed such a "danger." It is very possible, however, that the proposal may not be so regarded by other ratepayers.

Brighton – At yesterday's meeting of the Corporation the principal matter upon the agenda was as to the electric light undertaking At the time of going to press it is impossible for us to receive the deliberations so that we can only give an abstract of the suggestions made by the Lighting Committee, which were to the effect that the King's road should be lighted up to 11 o'clock p.m. by arc lamps, and after 11 o'clock with incandescent lamps, at an estimated cost for arc lamps of £875, and for the incandescent lamps £337, a total of £1,212 per annum, this being £290 in excess of the present cost of gas The capital outlay of this lighting would be about £2 700 The extension of the works is immediately necessary to meet the increasing demand for the supply of electricity, and the new area to be fed was given in the committee's report, and the estimated cost of the mains to be laid, as £12,350. It was reported that the capacity of the present plant is very nearly reached, and that, considering the probable increase of business, they would be warranted in putting down two 300 h.p steam dynamos and two sets of storage batteries. This addition, if one of the large 200-h p. dynamos be held in reserve, will bring the capacity of the station up to 18,400 8-c p lamps burning at one time, which is more than double what can be safely supplied with the existing plant. More boiler power would be required for the additional plant The total estimated cost of the plant required is £5,730, and for buildings about £1,700 Altogether it is estimated that the extension of mains in the present area, and the additional mains in the extended area, the new house services, the additional plant, the extension of buildings and contingencies, requires a total expenditure of £35,000. With regard to the revenue of the current year, the following was given as an approximate statement ·

Generation of electricity	£1,745
Distribution	10
Rates and taxes	50
Managing expenses	695
Special charges	88
Total	£2,588

The total revenue was £4,917. 10s 9d. After the interest and sinking fund had been paid there would be a profit of £108 10s 9d In conclusion, the committee further recommended as follows "1. That application be made to the Local Government Board for sanction to borrow a further sum of £35,000 for a period of 30 years, for the purposes of the Brighton Corporation Electricity Works. 2 That the portion of the premises belonging to the Corporation and adjoining the electricity generating station on the south, shown on the plan submitted herewith, be appropriated for the purposes of the undertaking and that a proportionate part of the debt created for the purchase of such land be transferred to and charged upon the undertaking 3 That the committee be authorised to carry out the works described in this report and to obtain such contracts as may be necessary for the purpose" The Works Committee, in response to an application from the Lighting Committee, recommended that they should be empowered to put the latter in possession of the whole of the land recently purchased in Church street, the Lighting Committee to take over the debt created by the purchase of such land.

Mansion Lighting —Benmore, near Kilmun, Argyllshire, the residence of H J. Younger, Esq has recently been fitted throughout with electric light the installation having been supplied and erected by Messrs Ernest Scott and Mountain Limited, of Newcastle. The engine and dynamo room and accumulator house is situated about 120 yards from the mansion. The generating plant consists of a Priestman patent oil engine, capable of giving from 18 to 20 effective horse-power, driving a shunt wound dynamo of Messrs Scott and Mountain's improved type, capable of running 200 16-c p. lamps direct, or of charging a set of accumulators capable of running 170 16-c p. lamps for about four hours The building containing the machinery is of an ornamental description, constructed entirely of stone, the accumulator house being placed at the end of the engine and dynamo room, so that the accumulators are kept away from the machinery At the end of the engine room is placed a main switchboard, consisting of an enamelled slate base on which is mounted an automatic switch for automatically switching in and out the dynamo at the correct moment. A main charging and discharging switch is arranged so that the dynamo can charge the accumulators, discharge the accumulators through the lamps, running the dynamo and accumulators together or, if necessary, running the lamps direct from the dynamo; and another switch is also provided by which the oil engine can be started by simply switching the current from the accumulators on to the dynamo, which runs as a motor, and as soon as the dynamo has started the engine, the latter quickly acquires its correct speed and then drives the dynamo and commences charging the accumulators. This arrangement entirely prevents the necessity of pulling the flywheel round in order to start. An ammeter and a voltmeter are also provided. The current from the main switchboard is taken to the house by underground cables Six cables are laid in wood troughing, filled in with bitumen and covered with cement, the object in providing these six cables being to enable the last five cells of the accumulators to be switched into circuit from a distributing switchboard in the house The switchboard which is placed in the main hall, is mounted on an enamelled slate base in a handsome oak case with a glass front The whole of the house has been fitted up with the electric light, and there are altogether about 180 16-c p. lamps in the installation. The scheme of wiring adopted consists in using terminal boxes placed one on each floor, the whole of the cut outs for each floor being placed in the terminal boxes, and there being in no case more than six lamps on any circuit By this arrangement the whole of the cut outs are kept together and, in the event of a light going out, a new fuse can be immediately inserted without having to hunt about to find the cut-outs. The electroliers and electric light fittings were designed specially for Messrs Scott and Mountain by the Manto Manufacturing Company The result is exceedingly pleasing, and the fittings have given every satisfaction This very complete installation has been carried out under the supervision, and to the specification, of Mr W A. Bryson, consulting engineer, Glasgow, Mr M B Mountain, of Glasgow, having supervised, on behalf of Messrs. Scott and Mountain, the erection of the installation

Epstein Accumulators. The Epstein accumulators appears to be meeting with favour for traction work, for we hear that the Epstein Company have received an additional order from the Birmingham Central Tramways Company for six sets of the accumulators, each set consisting of 96 cells of the T 9 type The first sets supplied have been in regular use for three months, and the satisfactory results obtained certainly go to prove the efficiency of these cells for traction work A point which is of the utmost importance to tramway companies is that the maintenance of these cells has been undertaken at a low rate, one which, while advantageous to the tramway companies, is also stated to be equally advantageous to the accumulator company With the upkeep of the batteries low, the working cost of the accumulator traction would be less costly than that of the overhead trolley system, and as their use is especially suited for crowded districts where poles will not be tolerated, we should certainly feel pleased to find that the introduction of the accumulator cars is helped forward by the use of the Epstein cells. These are not of the pasted grid type, but formed of corrugated solid plates of lead The difficulty of the use of secondary cells for traction work has always been a question of maintenance the short life of the so-called "positive" plates. When a cell of the pasted grid type is first electrically formed or when the polarity of a plate is intentionally reversed, it is noticed that the formation begins at the edges of the plugs, gradually extending towards the middle, thus proving that those parts of the active material which are nearest the grid participate most in the action of the electrode, the action diminishing towards the centre of the plug It is, further, a well known fact that the action of any electrode begins in that plane where the electrolyte and the electrode meet During the discharge of a secondary cell sulphate of lead is produced, which necessarily tends to occupy a much larger space than either peroxide of lead or the spongy or finely divided metal, of which the plugs consisted prior to the discharge The loss of capacity, the scaling and short circuiting, the falling out of the plugs when the cell has been allowed to discharge below the critical point of P D. 1·8 volts), are thus easily explained The too long continued discharge produces an excess of sulphate, and this sulphate is not evenly distributed through the plug, but abounds at the edges and at the outer surfaces. Consequently parts of the active material have not only become more or less inert, but the outer layers of the plugs, endeavouring to occupy more space than is allotted to them, come apart from the inner, less sulphated layer, and scaling and short circuiting follow as a natural consequence The Epstein cells withstand treatment which would be destructive to other cells. The entire absence of paste in their construction offers in itself great security, but the fact that the plates are solid lead castings, and that the active material, which is formed by direct oxidation blends inseparably with the lead accounts for their leading advantages The plates being corrugated on both sides, with a solid web in the centre, are very strong, and cannot buckle, and the extensive surface thus presented renders it possible to reduce the number of plates per cell considerably, and therewith the risk of accidents, while at the same time a saving in space is effected It was with these cells that Prof Ayrton consented to make tests with a view to ascertain, not what the behaviour of the cells would be when used with care but what the capacity and efficiency would become when their treatment is "worse than it ought ever to be in actual practice." For this purpose the cells (of which over 100 charges and discharges have been taken by him) were frequently left discharged for many days at a time, for example for as many as 17 days; further, the rate of discharge was very high, while the limit in discharging was taken lower and lower until it latterly fell to zero, the very worst treatment possible. But as for detrimental effects they were conspicuous by their absence, the capacity had not decreased, the plates had not buckled or short circuited, and they looked quite good and not at all spongy. The following comparison is given of the cost of plant between overhead and accumulator traction with Epstein cells. Taking for an example a representative line about 6½ miles in length, with a service of 25 cars, having gradients varying from 1 in 300 to 1 in 21, the approximate difference in the cost of conversion into either the overhead or the accumulator system will be as follows · Overhead Converting 6½ miles double horse track, including laying and connecting to rails of return conductor, at £400 per mile, £2,600, 6½ miles of overhead structure, iron poles, conductors, etc., at £3,000 per mile, double track, £19,500; total, £22,100. Accu-

mulators: Accumulators for 25 cars, 2½ batteries per car (five batteries divided between two cars), of such capacity as to enable a five to six hours' run with one charge, £13,500; balance in favour of accumulators, £8,600. Besides this, there will be a saving in the cost of machinery at the central station, which in the case of the overhead system must have a sufficiently large output to supply the maximum current found to be required by the whole of the 25 cars at any one time, and must in addition provide continuously the power consumed in the losses arising from the different transmissions. According to measurements made on several overhead tramways in the United States, the efficiency of the entire system—viz., the proportion of the brake horse power on the car motors as compared with the indicated horse power of the engines at the generating stations—has been found to amount in some cases to only 25 per cent., and in no case to exceed 40 per cent. in everyday practice. Taking an average efficiency of 33⅓ per cent., it follows that the boilers, engines, and dynamos at the central station will have to be so designed as to give at least 3 h.p. for every 1 h.p. of the car motor. With accumulators, the central (charging) station need only be of sufficient magnitude to charge one battery or one battery and a fraction per car at a time, and as the loss in power arises from a smaller number of transmissions (steam engines through dynamos to accumulators), as against the additional losses in the overhead system (from dynamos through the overhead wires, motors, gearing, to driving axle), a considerable saving in the cost of plant can be effected with the accumulator system. With regard to the efficiency it has been found that in the most favourable case where overhead wires are in use about 70 per cent. of the indicated horse power of the engines is transferred to the motors, while on most of the roads the percentage is between 50 and 60 per cent. Allowing for the loss of 10 per cent. in the dynamos, the efficiency between these latter and the motors is therefore on an average about 60 per cent. Prof. Ayrton found the energy efficiency of Epstein accumulators to be 84 per cent., while such batteries, which were regularly discharged and recharged in even the short time of three hours, gave an average energy efficiency of 76 per cent. It is therefore expected that the total efficiency of a line worked by Epstein accumulators, taking into account the increased weight of the accumulator car, will be higher than if the same line were worked by the overhead system, and at the same time the relative cost of coal per horse power, for the reasons given above, will certainly be lower. Referring to the question of maintenance, practical experience has enabled the Epstein Electric Accumulator Company to enter into maintenance contracts with tramway companies at a very moderate rate per mile run. For instance, on a line similar in character to the one before mentioned, with gradients varying between 1 in 300 and 1 in 21, and with cars of a carrying capacity for 50 passengers, this rate will only be 1½d. per car mile, which rate, in the opinion of the Epstein Company, will not only be sufficient to reimburse them for the renewal, but will leave a fair margin of profit. With a smaller outlay for the installation, no interference with rails and road and existing traffic, absence of poles and wires, greater security in the working, and a cost of working certainly not in excess of the trolley system, it should not be doubtful that accumulators are destined to play a large part on all lines where electrical traction can be introduced.

PROVISIONAL PATENTS, 1892.

October 11.

16641. **An improved coupling for lightning conductors.** Joseph Lewis, 5, Great Winchester street, London.

November 21.

21136. **Improvement in shade carriers for electric light pillars and brackets.** Joseph Taylor, 9, St. Augustine road, Camden square, London.

21147. **Improvements in and relating to electric vehicles for use on roads.** Charles Riley Garrard and Thomas William Blumfield, 37, Chancery lane, London.

21169. **Improvements in regulating apparatus for electric arc lamps.** Julien Dulait, 28, Southampton buildings, Chancery lane, London.

November 22.

21193. **An improved method of producing zinc from blende by electrolysis.** Gunnar Emil Cassel and Fredrik Adolf Kjellin, 11, Southampton buildings, Chancery lane, London. (Complete specification.)

21243. **Improved method of forming junctions between electric light cables and electric lamps.** Francis William Webb and Arthur Moore Thompson, Holly Bank, Crewe.

21268. **Improvements relating to suspension devices, chiefly designed for electric incandescent lamps.** Stephen Porter and John Robert White, 45, Southampton buildings, Chancery lane, London. (Complete specification.)

21273. **Improvements in and relating to electric clocks.** Martin Van Buren Ethridge, 45, Southampton buildings, Chancery lane, London. (Complete specification.)

November 23.

21292. **An electric alarm for gill drawing frames as used for flax and other fibres.** Adam McMeekin and John Logan, Cogry Mills, Doagh, co. Antrim.

21339. **Improvements in electrical indicators and connections therewith.** Robert Henry Kettle and Charles Graham, *Beaumont House*, Castelnau, Barnes.

21348. **Improvements in the treatment of zinc produced by electrolysis.** William Wright and John Bumfield Hamond, 1, Quality court, Chancery lane, London.

21372. **Improvements in insulators for electric telegraph wires and other electric conductors.** Bessie Alice Jeannette Espeut, widow and executrix of the late William Bancroft Espeut, 24, Southampton-buildings, London.

21376. **Improvements in electrical resistances.** Henry Edmunds, 47, Lincoln's inn fields, London.

21377. **Improvements in electric conductors.** Henry Edmunds, 47, Lincoln's inn-fields, London.

November 24.

21435. **An electric automatic repeater cut-out.** James Ferrée and James William Ferrée, 72, Reedworth street, Kennington road, London.

21480. **Improvements in the means or apparatus for measuring electricity.** George Lee Anders and Walther Kruger, 10, Jeffrey's square, St. Mary axe, London.

November 25.

21506. **Improvements in electrical governors for marine engines.** Hugh Archibald Fergusson, 62, St. Vincent street, Glasgow.

21530. **Automatic electrical signalling on locomotive engines.** Joseph Atack, 105, New Park street, Blackburn.

21533. **Improvements in apparatus for measuring electric potentials and quantities.** Guy Carey Fricker, Lincoln's inn fields, London.

November 26.

21613. **Improvements in telephonic transmitters.** Alban [illegible], 15, Water street, Liverpool. (Complete specification.)

21621. **Improvements in and in the manufacture of incandescent lamps.** Demetrius Von Mito, 4, [illegible], London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1889.

361. **Working metals by electricity.** Lake. (Thomson.) (Second edition.)

362. **Working metals by electricity.** Lake. (Thomson.) (Second edition.)

1890.

13006. **Working metals by electricity.** Lake. (Thomson.) (Second edition.)

1891.

18005. **Electric railway signals.** Ortega y Espinosa.
18938. **Incandescent lamps.** Langhans.
19071. **Incandescent lamps.** Langhans.
19554. **Electric switches.** Liront.
22184. **Telephones and microphones.** Rettig.
22339. **Secondary batteries.** Wladimiroff.
22837. **Electric arc lamps.** Bigland and Burns.
22852. **Electric meters.** Teague.

1892.

43. **Electric lighting of railway trains.** Houghton and White.
207. **Electric regulator.** Houghton and White.
259. **Utilising electrical energy for heating water, etc.** [illegible]
359. **Dynamo-electric machines.** Siemens Bros. and Co., Limited, and others.
360. **Rotary-phase current installations.** Siemens Bros. and Co., Limited. (Siemens and Halske.)
1641. **Electrometers.** Siemens.
13989. **Telephony.** Gibboney and Thompson.
14217. **Electric heat alarm.** Palmer and Desisle.
17563. **Electric lamp jointing.** Wynne.
18142. **Electric railways.** Booth.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	[illegible]
Brush Co.		[illegible]
— Pref.		[illegible]
City of London ...		[illegible]
Electric Construction	[illegible]	[illegible]
Gatti's	[illegible]	[illegible]
House to House	5	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	[illegible]	[illegible]
Liverpool Electric Supply ...	[illegible]	[illegible]
	5	[illegible]
London Electric Supply	[illegible]	[illegible]
Metropolitan Electric Supply		[illegible]
National Telephone	[illegible]	[illegible]
St. James'	—	[illegible]
Swan United	[illegible]	[illegible]
Westminster Electric...		[illegible]

which was installed by Messrs. Paterson and Cooper, is rendered available at night for football matches by electric light, and these matches take place twice a week, to the great admiration of the visitors, and with very successful effects.

Atmospheric Electricity.—M. Hermite, nephew of the famous analyst, has been making some curious researches by means of small free balloons. Very light but strong self-registering instruments are mounted therein so that they will not break. M. Hermite has obtained some interesting results on the temperature at altitudes of three to five miles. An address card was attached to these balloons, some of which descended 100 miles or more from Paris. Observations by means of long copper wires are being made on the electric state of the atmosphere. An account of these researches was presented to the Académie des Sciences on the 20th ult., at which meeting also some results upon the construction of the Mont Blanc Observatory, by M. Janssen, were also submitted.

Niagara.—Electrical engineers will muster in force on the 14th to hear Prof. Forbes discuss "The Utilisation of Niagara." It is well-known that Prof. Forbes has been largely occupied professionally for some considerable time back on this the largest electrical and hydraulic engineering enterprise of the world, and what is now to be said will be listened to with the greatest attention. As a side detail, Prof. Forbes seems to have his own ideas on the subject of philology as well as engineering, and those who attend his lecture will hear the beautifully soft true Indian pronunciation of Niagara (as Neeagaara) instead of our snappy insular attempt usually given to the name of the falls. Sir Richard Webster, Q.C., M.P., will take the chair, and from the universal interest of this subject of the utilisation and transmission of the energy of Niagara Falls, we anticipate a full meeting at the Society of Arts.

University Extension at Plymouth.—Plymouth and District Students' Association (Cambridge University Extension) met at the Free Library on Thursday last week, when Mr. Thomas P. Treglohan gave a lecture on "Frictional Electricity." The lecture was specially prepared for students qualifying for the examination that will immediately follow the course of lectures now being delivered under the Cambridge University Extension Scheme, and which must be passed by all who desire to become affiliated students in science to the university. The lecture was well illustrated with diagrams, and at the close a number of questions relating to the mathematical part of the subject was given to, and satisfactorily worked by, most of the students present. Before the lecture, Mr. Cumings, one of the members of the association, exhibited and gave a detailed explanation of a Gramme dynamo-electric machine of his own construction.

Test of a Submarine Boat.—The new submarine boat invented by Mr. Baker was successfully tested in Lake Michigan, some distance south of Chicago, last Saturday, in the presence of two members of the Torpedo Board of the United States Navy. At 10 o'clock in the morning the vessel was towed a mile out, an electrical expert and an engineer being the only persons on board. On the first trial the boat failed to dive below the surface, owing to her machinery being out of order, but, upon additional ballast being secured, a second and more satisfactory trial was made. The officers of the Torpedo Board expressed no opinion with regard to the boat's performance. They will forward their report to Commodore Folger, the chief of the Ordnance Bureau. The boat was built at a secluded point on the Detroit river. She is 40ft. long and 14ft. deep, and cost about 3,000dol. When under the water she is propelled by electricity, and when on the surface steam may be used, generated from oil fuel. She can travel under the water at the rate of 10 miles an hour. On the top of the vessel is a small observation tower, through which the crew can reach the interior. The tower is closed by a screw cap, and is provided with windows. The air is obtained from tubes running on the surface of the water by means of an electrical device.

Appointment.—In consequence of a rearrangement [illegible] the headquarter staff of the General Post Office, London, brought about by the death of Mr. Edward Graves, [illegible] late engineer-in-chief to the department, the important position of chief technical officer to her Majesty's Post Office has been conferred upon Mr. John Gavey, of Cardiff. Since the year 1872 Mr. Gavey has held the position of superintending engineer of telegraphs for the South Wales district, and has resided in Cardiff for the past 15 years, during which time he has been closely indentified with the [illegible] and scientific life of the town. For several years [illegible] has been a prominent member of the Cardiff Naturalists' Society, holding the office of hon. secretary for three years and the presidency of the society in 1890. Mr. Gavey has served the town for some time on the Free Library and Museum Committee, and has also been a member [illegible] Technical Education Committee since the introduction [illegible] the Technical Education Act, a position for which [illegible] fessional acquirements rendered him especially fitted. [illegible] Gavey has taken great interest in the development [illegible] telephone in his district, and the present effective [illegible] of telephone trunk lines connecting the various [illegible] centres of South Wales and Monmouthshire, [illegible] erected under his supervision.

Placing Turnouts.—The rules for placing [illegible] "turnouts" on the double line spaces on a [illegible] track is the subject of an article in the *Electrical* [illegible] November 19 by Mr. W. E. Harrington, B.Sc., [illegible] the question mathematically and practically. He [illegible] geometrical diagram to calculate the distances, [illegible] following rules: 1. The number of turnouts [illegible] number of cars is one less than the number of cars [illegible] 2. The time consumed between turnouts must be the [illegible] through; if irregular, this time must be that required [illegible] the longest distance even if others are only a small [illegible] of this distance. 3. The time between two [illegible] turnouts is half that between cars. As to [illegible] turnouts, two cases should be considered: First, [illegible] certain number of cars are to be run for the [illegible] portion of the time, and extra cars for odd and [illegible] intervals, the turnouts should be placed to suit the [illegible] business; second, in the case of a line running an [illegible] number of cars—for instance, a heavy business at [illegible] times of the day—as the lesser number of cars are [illegible] nate to the greater number, the turnouts must be [illegible] to run the large number efficiently. The gradients, [illegible] thoroughfares, stoppages by level crossings, and [illegible] business must, of course, all be considered. The [illegible] matter of turnouts is exceedingly simple when [illegible] are known, but a tramway line cannot be run [illegible] unless the managers are conversant with these [illegible]

Welcome to America.—A letter to the [illegible] effect has been received by the Secretary of the [illegible] of Electrical Engineers from representatives of the [illegible] important American engineering societies: "[illegible] view of the probable attendance of many of your [illegible] at the Columbian Exposition, to be held at Chicago [illegible] year, we desire to assure you of the hearty welcome [illegible] awaits them on their arrival in New York from [illegible] fessional brothers of the American Society of [illegible] neers, the American Society of Mechanical Engineers, [illegible] American Institute of Mining Engineers, and the [illegible]

Institute of Electrical Engineers. The homes of these several societies will be open to such visitors as are duly accredited through the secretaries of their respective associations, and efforts will be made to facilitate the objects of their visit. Anticipating for ourselves much pleasure in carrying into effect the wishes of our constituent societies, and in looking after the interests of our visitors, we have the honour to be, very truly yours, Mendes Cohen, A. Fteley, and John Bogart (committee of the American Society of Civil Engineers); J. F. Holloway, Henry R. Towne, and S. W. Baldwin (committee of the American Society of Mechanical Engineers); F. G. Spilsbury, F. S. Witherbee, and C. Kirchoff (committee of the American Institute of Mining Engineers); Franklin L. Pope, Jos. Wetzler, and Francis R. Upton (committee of the American Institute of Electrical Engineers). By order of the committees, C. Kirchhoff, secretary, New York."

Electrical Fire Risks. — With reference to the solicitor's letter to the *Times* on insurance risks, which we quoted the other day, the *Fire Insurance Review* says: "From the record of some recent fires, we should say that the sooner the public are made aware of the fact that the average gasfitter or plumber is not by virtue of his calling fitted to take charge of the installation of the electric light, the better for both the householder and the fire offices. Meanwhile it may be as well to know that the installation of the electric light, if unaccompanied by a survey and permission by the fire office to use it, does constitute an extra risk, and imperils the security of the assured to a very great extent. And for this special reason, that whilst an electric light fire generally consumes the evidence of its guilt, yet if a fire does occur in a house where an electric installation has recently been made, it will be found exceedingly difficult to prove that it was not the electrical installation which caused it. We would suggest that all fire offices print in large letters in their Christmas notices, that where installations of electricity have been made, the same must be declared at once to the fire office interested. We know ourselves of one large house in the North of England where 1,100 lights are at work, or may be worked, and we also know that the fire insurance company interested has never called for a report of an electrical engineer on the installation. We cannot help thinking that the fire office itself is very much to blame in the matter—that is to say, if it is aware that the house is lit by electricity." It is really, we think, part of the duty of the electrical contractors, and we strongly advise them in every case to let their clients know of the necessity for the proper notice to the fire office.

A New Cable-Making Machine.—A cable-making machine of a new type has been recently completed by the New England Butt Company, of Providence. It is for New York manufacturers, and was designed, says the N. Y. *Electrical Review*, to meet the growing demand for telephone cables to be laid underground. The machine is [illegible]ft. wide and 56ft. long, and is composed of five heads, revolving in different directions and driven by gears on a shaft extending the entire length of the machine. Upon each head is placed the desired number of reels containing the wire, which, preparatory to the cabling process, is covered with two layers of paper. Each layer of paper is bound on the wire, and two wires are then "twinned," or twisted together. On the first head are reels for making a cable of [illegible] wires, the wires unwinding from the reels as the head turns and passing through an aperture at the centre of the head. The other heads have similar reels of twinned wire, and increase the size of the cable by adding wires until the cable is 2½in. in diameter, and is composed of 120 wires. As it leaves each of the heads the cable is bound together, and when completed is covered with jute, hemp, flax, or cotton. Passing from the last of the series of heads, it goes around a wheel 5ft. in diameter, and is then wound on a drum and is ready for the treatment preceding its encasement in lead pipe. Attached to the machine is a measuring device. The cable rests on a large pulley, and is held there by the weight of a loosely-mounted circular block. As it passes through the machine it turns the pulley, which is geared to plates or dials on which are figures indicating the number of feet of cable that have been drawn over the wheel. The capacity of the machine is from half a mile to a mile per day, and its advantage is in completing the cable at one operation, and avoiding injury to the wires by frequent handling and bending, which has been the defect of previous machinery for making telephone cables.

Multitubular Accumulator.—M. D. Tommasi sends us some particulars of his multitubular accumulator which will be found interesting. This accumulator is characterised by electrodes enclosed in a tubular envelope or metallic sheath, or in any rigid or elastic insulating material, such as celluloid, ebonite, indiarubber, etc., perforated with a large number of small holes. In the centre of this sheath is placed a core of lead or alloy, or of other metal suitable to serve as conductor to the current, and in contact upon each of its surfaces with a coating of oxide of lead preserved from falling or disintegration by the perforated envelope which imprisons it. This arrangement has the double advantage of doubling the amount of active material, and thus the capacity, of the accumulator for equal weight. The cell is therefore light, of great capacity, and small volume. The charging current can be calculated at 5 to 6 amperes per kilogramme (2 to 2½ per pound). The discharge can be varied from 1 to 4 amperes per kilogramme (say, ½ to 2 per pound) of electrodes. It should be stopped when the voltage falls to 1·7 volts. In cases where sudden variable discharges are necessary the Tommasi accumulator can bear 6 to 8 amperes per kilo (say, 2½ to 3½ per pound) of electrode without inconvenience. The electrical constants of this accumulator are as follows:

Initial E.M.F.	2·4 volts
Capacity per kilogramme of electrode...	20 ampere-hours
„ per pound of electrode........	9 „
Efficiency in quantity	95 per cent.
„ in watts	80 „

In announcing a capacity of 20 ampere-hours per kilogramme, M. D. Tommasi has adopted mean discharge, which may vary between one and three amperes per kilogramme of electrodes. It is evident that by employing a lower mean the capacity would be increased. To obtain a comparative idea as to the large capacity of the Tommasi cell, it is sufficient to compare it with known types used in lighting and traction, and M. Tommasi claims that the capacity of his accumulator is from three to five times that of the best known types. The simplicity and strength of the construction of the Tommasi cell are great points in its favour, and we doubt not that it will render considerable service in practical work. We believe a company has been recently formed in Paris to manufacture this accumulator, of which great things are expected by those interested therein.

Electric Railway Signals.—A very necessary reform in railway fog signalling is alluded to by Mr. J. Stones, of Smethwick, in a letter to the Birmingham *Daily Post*, and as we have already given some prominence to attempts in this direction, it may, perhaps, be well to give this letter in full. Experiments were undertaken at King's Cross, but were dropped, we fancy, through quarrels between the

inventors. There is no reason for not continuing the research after this much desired perfection, with reference to which Mr. Stones thus writes: "It appears to me that an improvement could be made in the present system of signalling trains by having a telegraphic instrument fixed on the engine. This could be communicated with the signal-box by laying a wire alongside the rails, loose, in V-shaped insulators, and fixing a pulley on the engine or tender at sufficient height to pick up the wire as the train travelled. The return, or earth wire, need only be fixed to any part of the engine, and the current would pass through the wheels to the earth. If this was done, the driver, or brakesman, would be in constant communication with the signalman. Of course, the line would be divided into sections, and when the train entered upon any section the brakesman would ring the bell in the signal box, and get a reply 'train on line' or 'line clear. This would be more satisfactory to the driver than seeing a signal 'off,' because he would know that he was getting proper attention, and if he got no reply to his 'bell' he could pull up the train and see if the signalman was dead or asleep. There would also be a great advantage in this system during fogs, as it would not be necessary to see any signals along the line at all, and by insulating the wire, say, at 500 and 200 yards from every station, the driver would know exactly where he was, and could pull up the train at the platform without lights as well as with them. It is well known that during a foggy day the trains are altogether disorganised as regards keeping time, and when a fog comes on suddenly, no matter how well the thing is managed, it must take time to get the fog-men along the line, and while they are 'fogging' they must be neglecting some other duty." The practical difficulties are great, no doubt, but we cannot think that the inventiveness which has overcome so many obstacles can rest satisfied with the periodic dislocation of our traffic which occurs every year in the winter months.

Electro-Metallurgy. Mr. J. W. Swan lectured at the Midland Institute at Birmingham, on Monday, on the subject of "Electro-Metallurgy." The lecture was well illustrated with lantern experiments and a collection of specimens, including a reproduction of the famed Milton shield by Elkington's, together with map and picture engraving electros. Mr. Swan pointed out how large a position Birmingham had taken in the development of electro metallurgy, quoting the names of Elkington, Mason, Woolrich, and Gore. He went through, in an interesting manner, the history of the development of electroplating. Daniell's battery was not invented till 1836, and there could be no question that it was this invention that directly led the way to electrotyping. In the same year, De la Rue observed that the copper coating produced in Daniell's battery could be stripped off. In 1839, Jacobi, and Spencer, and Jordan independently published papers in which the artistic use of the electrolytic copper deposit was proposed. Long before this time electro gilding and electro-silvering had been done in an experimental way in the laboratory, but nothing of a practical kind had resulted. To develop the abstract scientific fact into the useful art required that combination of scientific knowledge with practical faculty and insight which Birmingham had so often produced, and which was supplied in this case by Elkington and Mason. "Ah," said Daniell on one occasion, "I have let two or three fortunes slip through my fingers. I have had all the labour, and those Birmingham people are getting all the profit." Precisely parallel was the case of Faraday, who left to Woolrich (another Birmingham man) the honour and the profit of giving practical effect to his discovery of the principle of the convertibility of motive power into electric current. Having illustrated the process of electro-deposition by experiments and views, the lecturer pointed out that the characteristic of an electrotype was extreme fineness. It was this feature that had given so great an advantage over casting in the reproduction of elaborate and artistic metal-work, that had, in fact, led to the creation of a new art-metal industry, in which masterpieces of chasing and engraving, both ancient and modern, were so perfectly reproduced that it was sometimes difficult to distinguish the original from the copy. The lecturer explained the processes of electroplating, and alluded to the plating by iron of engraved copper plates for maps—when used the iron could be dissolved and the plate recoated. The invention of the dynamo produced the most astonishing growth, and the refining of copper by electricity now produced between 30 and 40 thousand tons of copper a year. Aluminium was reduced in price to 2s. a pound by the same means. Mr. Swan then described the Thomson and Benardos systems of electro-welding, Birmingham having a special interest in the latter process. Concluding, the lecturer drew a picture of expected progress in the future, and, on the motion of Councillor Martineau, was awarded a hearty vote of thanks.

Durham College of Science.—On Monday the foundation-stone of the new wing of the Durham College of Science was laid by the Earl of Durham in the presence of an assembly of professors, scientific men, and local celebrities the list of whose names occupies half a column of an ordinary newspaper. After laying the stone in the usual manner, the Earl of Durham distributed the prizes. He hoped the prize giving would be all right. When he was a boy he at first thought the proper thing to do was to work, but that impression did not last long. He obtained a prize at the end of the first half, and he did not think he ever got another. His interest in geology was confined to putting stones in the keyhole of the classroom door and watching the efforts of the master in trying to get them out. This did not add to his studies. He hoped the students would always enjoy themselves in their work, and he wished them success. The students present thereupon sang "For he's a jolly good fellow." Other speakers followed, and letters of regret were read from Lords Armstrong and Ravensworth. At the dinner in the Assembly Rooms, Lord Durham proposed "The College of Science." He confessed his absolute and entire ignorance of science, his profound admiration and awe of professors and experts, and his readiness to believe anything they told him except that he could fly or be made young again. All the professors in the world could not make him believe he should become a young angel. But he trusted he was sufficiently intelligent to appreciate the advantages that science had brought. Largely, through efforts of the men of Tyneside, students had facilities for study that George Stephenson had not, and, as Stephenson said, the mistakes of young mechanics who thought they had hit upon some great discovery would be avoided by study and reading of books. The progress during the Victorian era had been so great that most people are prepared, with a few reservations, to receive not incredulously the announcement of almost any discovery. He felt the college had a glorious future before it, and although he believed that our progress had been hitherto made more by muscle than intelligence, he looked to the college to aid in the altered state of things, in adding to the wealth, glory, and honour of the British Empire. Prof Garnett, in reply, alluded to the success of the college, stating that in the last two years the expenditure had increased twofold and the number of students and professors still more

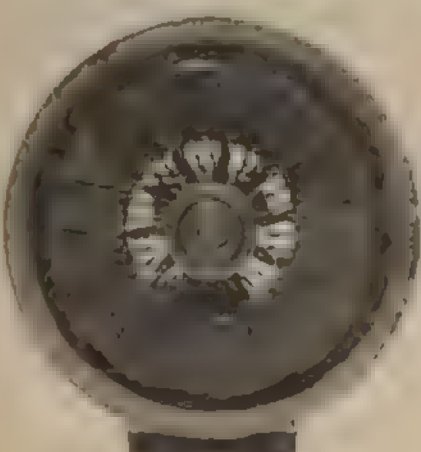
The most important section was the George Stephenson Engineering Department, for which one lady had presented a testing machine, and another a bust of Stephenson. He alluded to the progress of engineering education in the Yorkshire College and at Bristol, and now the engineering department at Durham would be one of the best equipped in the kingdom. Councillor W. Robinson replied on behalf of the Durham County Council, promising support; and Mr. Robert Thompson, president of the North-East Coast Institution of Engineers and Shipbuilders, also congratulated the college on their addition, and hoped the laboratory would also soon have a quadruple-expansion steam engine. The health of the chairman was then pledged with applause. The management of the college is greatly to be congratulated on the great progress which has necessitated the extension.

Zurich.—The installation of electric supply at Zurich has met with very satisfactory success. The installation was designed for a first supply, by high-tension alternators with transformers, of 10,000 16-c.p. lamps, to be subsequently increased to 20,000. There are, besides, 130 arc lamps for public lighting from the railway station to the lake. The generating power is obtained from hydraulic power—viz., 590 h.p. by two high-pressure turbines actuated by high-pressure water, 340 h.p. by two reaction turbines actuated by ordinary water power. There are also two steam engines of 230 h.p. in reserve. In practice not more than two-thirds of the incandescent lamps are alight simultaneously, even at the time of maximum in the winter, when, moreover, the number of arc lamps on the lake is reduced to half. The actual generating power required is about 533 h.p. The electric station constitutes a part of the pumping works. The arrangement of machinery is peculiar. The two high-pressure turbines provided with automatic regulators drive the four alternators on the same dynamo shaft to which the main shaft, by gearing of 1 to 3, transmits additional power from the reaction turbines or the steam engines. By means of friction couplings, the dynamo shaft can be worked in three parts, jointly or separately—two parts with high-pressure turbines with accumulated hydraulic energy for night service, and one part with the reaction turbines or the engines for day service. The alternators give, at 2,000 revolutions, 100 amperes at 2,000 volts each, or a total of 800,000 watts. They are excited by two small high-pressure turbines, driving two dynamos of 30 h.p. on the same shaft at 400 revolutions. The main and subsidiary cables are designed for a supply of 20,000 incandescent lamps. The primary cables, laid in a brick channel 2ft. below the surface, consist of four concentric high-tension (2,000 volts) cables, 40 millimetres square in cross-section, from the central to the distributing station in the centre of the town. The distributing station (2,420 yards up the river) consists of a masonry hut, 20ft. by 10ft., from which radiate the secondary mains, also laid in brick channels, leading to 18 transformer stations; these being circular iron boxes 3ft. 3in. diameter and 9ft. 10in. in height, containing altogether 44 transformers, which convert the high-tension current of 2,000 volts into low-tension currents of 100 to 200 volts for both house supply and street lighting. Both the primary and secondary cables are composed of single insulated copper wires, varying between 25 and 250 square millimetres (0·039 to 0·387 square inch) in section, with a double lead covering. Three secondary mains are always laid in one brick channel, the centre cable being for safety connected to earth in all transformer stations. The arc lamps for street lighting are mounted on standards 23ft. to 26ft. high, placed at equal distances apart of about 197ft. The sections of the copper cables are calculated from the formula $Q = \frac{2\,l \times J}{60 \times E}$; Q being $> \frac{J}{2}$, in which Q is the section in square millimetres, l the distance from the transformer in metres, J the current in amperes, and E the loss of tension in volts; a margin of 20 per cent. being added, and the sections being rounded off to current dimensions, between 25 and 250 millimetres square as mentioned above; whilst sections between 350 and 500 millimetres square are formed by combining smaller sections. The loss of energy being 5 per cent. between the dynamos and transformers, and 7 per cent. between the transformers and lamps, the energy of an incandescent lamp of 60 watts is reduced to 53 watts, or 0·26 ampere; and that of an arc lamp of 900 watts to 791 watts, or four amperes, at the point of consumption. The guaranteed efficiency of the transformer is 95 per cent. when fully, 92 per cent. when one-half, and 86 per cent. when one-quarter, loaded; and the loss when running unloaded is not to exceed 3 per cent. of the total capacity, which is 20,000 watts for each transformer. The 44 transformers therefore have a total capacity of 880,000 watts, sufficient for a maximum supply of 15,000, 18,000, or 20,000 lamps, according as the whole, three-fourths, or two-thirds are lighted simultaneously. The cost of installation designed for 10,000 incandescent and 130 arc lamps, including the electric machinery and distribution, but exclusive of the building, hydraulic machinery, and steam engines debited to the water works, is £48,560—equivalent to £628 per arc lamp of 900 watts, including standard and lamp—and about £4. 3s. per incandescent lamp of 60 watts. The total annual working expenditure, including interest and sinking fund, is £12,000; of which £3,480, for the 130 arc lamps (235,600 hours), and £8,520, for 10,000 incandescent lamps (5,000,000 hours)—being about 3·6d. per arc lamp (twice as dear, but five to ten times as much light as gas), and 0·4d. per incandescent lamp per hour. Hence the rates fixed for the supply of private incandescent lighting, based on a price of 0·76d. per unit, vary from 8d. to 4·25d. per lamp per hour, the mean being 0·6d. per lamp per hour for 1,000 hours, exclusive of the first cost of lamps and fittings and of the wear and tear, which amounts to about 0·05d. per incandescent lamp, and 1d. per arc lamp per hour. The rates include an annual fixed meter charge of 8s. for each lamp. These rates are 20 to 30 per cent. higher than those charged for the gas supplied by the Corporation gas works, and were so fixed with a view to protect the latter against injurious competition. The rates charged for electric lighting in other Swiss towns are very similar to those of Zurich—*e.g.*, at Lausanne, 0·72d. plus an annual charge of 36f.; at Vevey-Montreux, 0·42d.; at Geneva, 0·5d. per lamp per hour; while at Lucerne, a fixed charge of 16s. is made per 10-candle lamp per annum. The receipts from the 130 arc and 10,000 incandescent lamps are £14,640 per annum; the net surplus, after allowing for interest and sinking fund, is £2,640; and the total return on the capital expenditure of the electric installation, properly speaking, is 13·6 per cent. The special committee appointed by the Corporation recommended the erection of the installation proposed by the Oerlikon Works, near Zurich, which accordingly supplied the electric machinery; while Messrs. Escher, Wyss, and Co., of Zurich, furnished the hydraulic machinery; Messrs. Sulzer Bros., of Wintherthur, the steam engines; and Messrs. Berthoud, Borel, and Co., of Cortaillod, near Neuchatel, the cables, standards, arc and incandescent lamps, transformers, and accessories. These particulars are taken from a paper by Mr. Charles Du Riche Preller, on "The Zurich Water and Electric Works," in the selected papers of the Institution of Civil Engineers.

SIR DAVID SALOMONS'S FREQUENCY-RAISING MOTOR.

The greatest interest was manifested at the meeting of the Institution of Electrical Engineers last week over Sir David Salomons's new machine for obtaining a high frequency alternating current from any ordinary direct current. We were able in our last issue to give the first public description of this machine that has been issued, as correct and full as the short time at our disposal allowed; one clerical error will have been noticed, which we take the opportunity, in giving this fuller description, to correct—namely, that the "3,000 revolutions giving one million 'revolutions'" spoken of should, of course, have been "3,000 revolutions giving 'one million alternations' per minute.

Sir David Salomons's Direct-to-Alternating Motor Transformer.



Armature half.

The machine is the outcome of an ingenious idea. "Why could I not," said Sir David Salomons to himself, "construct an ordinary continuous current motor which should drive on the same disc an alternating current machine having an enormous number of poles? I should then obtain a low-tension alternating current of great frequency, which could be transformed up by an ordinary oil transformer and rival Tesla's current." This was the generating idea, and it has been carried out in an exceedingly ingenious manner by Sir David Salomons and Mr. L. Pyke. Mr. Pyke, as is well known, has lately made a speciality of high tension work, and his oil transformers, condensers, and induction alternating machines are interesting pieces of work in the little-explored field now associated with the name of Tesla. The details of the proposed machine having been discussed between them it was soon seen that to obtain the frequency demanded, of a million alternations per minute, a machine would be needed of considerable diameter, even for the smallest output. The idea then occurred to have both the field magnets and the armature of the continuous-current motor which was to act as driving power equally capable of rotation in opposite directions—a speed, each of 1,500 revolutions would then mean a total passing speed of 3,000 revolutions per minute. To obtain a million alternations, 360 reverses per revolution were needed, and a little calculation and trial showed that this could be done quite easily with a

Field magnet half.

ring of 1ft. in diameter only to form the alternating machine. By suitable careful arrangement the current which passed into and drove the motor was made to supply also the alternating current field magnets, and the final current thus yielded by the little alternator, though greatly reduced in quantity, is of the frequency of 1,000,000 per minute. Seeing that with Tesla's machine, which had to be driven by belting, and was 3ft. in diameter, an initial frequency of only about 300,000 per minute was given, it is seen that to obtain a frequency of 1,000,000 with a machine only 1ft.

in diameter, and one, moreover, that drives itself, a very neat little problem in high-frequency currents, more especially for experimental purposes, has been solved.

The appearance of this little machine is shown in the reproductions from the photographs. It is built in two halves, which are quite unattached (except through magnetic force), each half being capable of spinning on long bearings, from which the disc overhangs. The two are shown separated in one photograph, and complete, as in use, in the other. Taking the direct-current field magnet side first, it will be seen that there are two field magnets presenting flat sides to the opposite disc.

The brushes are mounted inside the machine upon these field magnets, separated therefrom by blocks of ebonite. The current comes in at two rings on the spindle, passing through the hollow spindle to the brushes. The current used is eight amperes at 100 volts continuous current. So much for the inside of the first disc. The outside of this disc consists, as shown, of a ring of soft iron, separated from the field magnets inside by a stout ring of ebonite. This iron ring is 1ft. in diameter, and is ploughed out in grooves, 10 to the inch—a total of 360 poles. These poles are wound exactly as for alternating-current field magnets—alternate north and south poles, wound Ferranti fashion, with No. 20 treble-insulated copper wire, made specially for the purpose. The windings are connected, two-and-two in series, and the whole of the sets are in parallel, the ends being joined together and connected in shunt to the inside motor brushes. They are thus in parallel with the motor on the 100-volt circuit, and when the current is on there are 360 alternate north and south poles.

Now, turning to the second disc, shown in the photograph beside the first. This disc contains, inside, the armature of the direct-current motor, and outside the many-pole alternate-current armature, as the first disc contains the fields. The armature of the motor inside the disc is in the form of a flat Gramme ring, and is connected by a commutator in the usual way to the brushes. When current is turned on, the reaction of course turns to drive the armature round, but the field magnets being also free they also revolve in the opposite direction. A speed of 1,500 revolutions a minute each produces, as we have said, a total of 3,000 revolutions.

The armature of the 360-pole alternator is mounted, in the same way as the field magnets, on the outside of the disc, and the revolution produces an alternating current in the wires of this armature. Eight amperes continuous current is put in at one end at 100 volts, and half-ampere alternating current is taken out at the other at 100 volts, but at a million reversals per minute. The efficiency, it will be seen, is not very high, being $\frac{1}{16}$th, or 7 per cent., the balance being all absorbed in heating and friction; but half-ampere is sufficient to experiment with, and Sir David Salomons thinks that he eventually can obtain $1\frac{1}{2}$ amperes or more.

The current so obtained is now passed into an oil transformer, which transforms the current from 100 volts up to 100,000 or so. The machine has been run off the Westminster Company's mains, and 1,000 1ft. vacuum tubes in series have been lighted by this means. Sir David Salomons has also taken the current into his body without dangerous effects, and tubes have been lighted without other connection by the hand.

So far we seem to have a distinct advance in the interesting subject of the production of vibratory currents, by the manufacture of this highly ingenious combination. There remains two questions to discuss, one of which we hope to see satisfied experimentally. The first is the lighting efficiency. Eight amperes at 100 volts will light about 16 ordinary 16-c.p. lamps. By the Salomons directo-alternator the current will light 1,000ft. of tube. We might take 1ft. of tube at $\frac{1}{10}$th c.p. The 1,000ft. would in that case (which we do not vouch for as a correct valuation) give 100 c.p., as against $16 \times 16 = 196$ c.p. on the usual system, or only 50 per cent. There is not much to be gained here therefore. But we are, of course, only at the experimental stage. Seven per cent. efficiency for the motor leaves a large margin, and the luminous efficiency of the tubes may be raised—who knows? At any rate the investigation is of the greatest scientific value, and will no doubt be productive of good results.

The second point is more alarming. We have no wish to frighten Sir David Salomons, but we do not wish to have one of our most enthusiastic experimentalists "hoist with his own petard." Testing with his own body pressures like 100,000 volts are all very well with small currents. No sooner is contact made than the E.M.F. falls at once and is wiped out. But with larger currents this may not be quite so quick in happening, and—well, we give the same advice as we gave to Prof. S. P. Thompson: try it on a calf first.

The great difficulty experienced with these high-tension vibratory currents is to insulate them. No ordinary wire will hold the current, which prefers to excite electrostatic effects on surrounding molecules. We congratulate Sir David Salomons on the interesting result of his idea, and also his earnest coadjutor, Mr. L. Pyke, on the outcome of their endeavours.

ELECTRIC LIGHT AND POWER.

BY ARTHUR F. GUY, ASSOC. MEM. INST. ELECTRICAL ENGINEERS.

VI.—OHM'S LAW AND THE ELECTRIC CIRCUIT.

(Continued from page 567.)

Heating Effects of the Current.—The resistance of all metals rises in proportion to the rise of temperature, the only exception being carbon, the resistance of which falls in proportion to its rise of temperature. For copper the increase of resistance is about one fifth of 1 per cent. for every degree F., or about three-eighths of 1 per cent. for every degree C.; suppose a copper conductor at an atmospheric temperature of 65deg. F. has a resistance of one ohm, then at a temperature of 95deg. F. its resistance would be $1 + 1 (30 \times \cdot 002) = 1 + \cdot 06 = 1 \cdot 06$ ohms. With gutta-percha, the resistance falls as its temperature rises, and this is the case with liquids. It was stated that there is no material that offers no resistance to a flow of electricity, and it was also stated that energy was spent when a current was forced along a conducting path against the resistance of the path. This energy is wasted on the conductor, and appears in the form of heat, the heat energy being exactly equal to the amount of electric energy that produced it. When a unit of current is forced through a unit resistance, one erg of work is done, and to do this requires one unit of difference of potential. When a mass falls through a difference of level the work done is measured by the weight of the mass multiplied into the difference of level or distance through which it falls; similarly with electricity, the difference of potential corresponds to the distance, and the quantity of electricity corresponds to the weight of the mass: hence difference of potential multiplied by the current will likewise measure the electric work done. One ampere flowing for the space of one second under an electrical pressure of one volt will therefore do $\cdot 1 \times 10^8 = 10^7 = 10{,}000{,}000$ ergs of work per second, because one ampere $= \cdot 1$ of a C.G.S. unit, and one volt $= 10^8$ C.G.S. units, 10^7 ergs per second = one watt, hence one watt is the practical unit of electric energy. So that we have

$$\text{amperes} \times \text{volts} = \text{watts};$$

746 watts make 1 h.p., therefore we may measure electrical power by multiplying the pressure in volts by the current in amperes, and dividing by 746, or

$$\frac{\text{volts} \times \text{amperes}}{746} = \text{horse-power.}$$

The output, or capacity, of dynamos is usually reckoned by kilowatts—a kilowatt signifying 1,000 watts—thus a dynamo designed to work at 110 volts pressure, and to give a maximum current of 500 amperes, is said to have an output of $\frac{110 \times 500}{1{,}000} = 55$ kilowatts; now, since 746 watts equals 1 h.p., therefore one kilowatt is, roughly, equal to $1\frac{1}{3}$ h.p., or 1 h.p. is equal to three-quarters of a kilowatt.

In the same way as steam power is sold or measured by horse-power hours, so electrical power is sold or measured by kilowatt-hours — one kilowatt-hour being named a

Board of Trade supply unit. One kilowatt-hour, or briefly, one "supply unit," is defined by the Board of Trade to signify 1,000 watts of electrical energy acting for the space of one hour. Hence one "supply unit" = 1,000 amperes flowing under a pressure of one volt, or 100 amperes under a pressure of 10 volts, or 10 amperes under a pressure of 1,000 volts, or generally 1,000 volt-amperes, for the space of one hour.

The amount of electric energy that is spent or wasted in the conducting wires is evidently found by multiplying the current that is flowing by the difference of potential that there is between the ends of the conductor, for this difference of potential measures what is technically called "drop" of potential, and signifies the pressure that is absorbed or lost in forcing the current through the resistance of the length of conductor. According to Ohm's law, volts = amperes × ohms, or E = C R, and energy wasted in the conductor is "drop" in volts × amperes, or E C, therefore, substituting the value of the volts, or E, we have energy wasted = (amperes)² × ohms, or $C^2 R$. Hence the energy wasted in the form of heat in a conductor is obtained by multiplying the square of the current by the resistance of the conductor.

The amount of heat energy generated by the flowing of the current through a conductor can be easily calculated. By inserting a coil of German-silver wire of known resistance in a bath of paraffin oil, and passing a known current through the wire, the heating effect will be shown by the rise of temperature of the oil. From numerous and careful experiments made, it is found that multiplying the electric energy wasted in the wire by the number ·24, gives the heating effect of the current per second in heat units, or calories, hence we have the following formula:

$$H = C^2 R t,$$

where H = calories = number of grammes of water raised 1deg. C., and t = time in seconds.

It is thus seen that the energy wasted is proportional to the square of the current, and directly to the resistance. The rapidity with which a substance dissipates or throws off heat is named the emissivity, and the heat generated in a conductor should be thrown off as quickly as it is produced there. The emissivity depends on the cooling surface, and this is measured by the circumference of the wire multiplied by its length, since circumference is proportional to diameter, hence the cooling surface of a wire is proportional directly to diameter. But the current that a wire will carry is proportional to the square of the diameter, since double the diameter gives four times the area, and therefore four times the current can be carried. The resistance is now only one fourth of what it was before, so that the electrical energy wasted by a wire of double diameter is $C^2 R = 4^2 \times \frac{1}{4} = 16 \times \frac{1}{4} = 4$ times what would be wasted in a wire of unit diameter, each wire having the same current density. We thus see that while the heat energy generated is fourfold, the cooling surface is only twofold, consequently the larger wire must become much more heated than the smaller wire. So the smaller a wire becomes, the greater is the current it will carry in proportion to its area; and the larger a wire becomes, the less is the current it will carry in proportion to its area. For example, suppose a wire of ½in. diameter will carry 400 amperes without overheating, it will be found that a wire of 1in. diameter carrying its proportional current—namely, four times 400, or 1,600 amperes—would become much hotter than the first, and a wire of ¼in. diameter, carrying 100 amperes, would become much cooler. The quantity of current per unit area is the same—that is, the current density, as it is called, is the same for all three wires; the explanation lies in the fact that the cooling surface is proportionally largest in the thinnest wire, and smallest in the thickest wire. Divide the 1in. circular wire into four circular strands or parts, each having one-fourth the sectional area of the solid wire; the cooling surfaces of the four stranded and one solid conductors will be in the ratio of $\sqrt{4} : 1 = 2 : 1$, because each strand will have one-half inch diameter, and four times one half equals twice one.

If this same solid conductor be divided into nine strands, each having one-ninth of the total sectional area, then ratio of cooling surface, as compared with the solid conductor, will be $\sqrt{9} : 1 = 3 : 1$; so that the cooling surface in this case will be trebled. The ratio can be at once obtained for any number of strands, putting the solid conductor at unity and taking the square root of the number ($\sqrt{n}$) of the strands for the stranded conductor.

We are now in a position to calculate out the temperature to which a given conductor will rise when a given current is sent through it, and by fixing this temperature at a safe limit, which must not be exceeded, we can then get at the greatest current that can flow without raising the temperature of the conductor beyond this fixed safe limit.

A wire which would become heated to about 24deg. C. or 75deg. F., while at atmospheric pressure, would, with the same current flowing through, become red hot when the pressure is reduced to, say, $\frac{1}{1 \cdot 7 \times 10^6}$th part of an atmosphere, thus proving that far more heat is conveyed away by convection than by radiation. The latter pressure is somewhere about that which remains in an incandescent lamp when so much air is exhausted that it may be said practically to be a vacuum.

The emissivity of copper, or the rate at which heat is dissipated from its surface, is ·0003 of a calorie per second for every square centimetre of exposed surface (one calorie being the heat necessary to raise one gramme of pure water 1deg. C.), for every difference of temperature of 1deg. C. between the wire and surrounding bodies. Hence the total heat emitted = ·0003 T S calories per second, where T = difference of temperature in degrees C., and S = exposed cylindrical surface in square centimetres. It has been shown that the total heat generated in the wire is expressed by ·24 C^2 R calories per second, where C = the current in amperes, R = resistance in ohms; and since the heat emitted or dissipated should be equal to the heat generated, therefore ·0003 T S = ·24 C^2 R, or

$$T = \frac{\cdot 24\, C^2 R}{\cdot 0003\, S} = \frac{800\, C^2 R}{S}.$$

So that multiplying the electric energy wasted in the wire by 800, and dividing by the square centimetres of exposed surface, will give the number of degrees C. of temperature the wire will be raised above the temperature of the atmosphere.

We have also, $C = \sqrt{\left(\frac{\cdot 0003\, T S}{\cdot 24\, R}\right)}$.

This formula gives us the maximum current a wire may carry, so that its temperature shall not rise more than T degrees C. above that of the atmosphere. In practice conductors should not be heated more than 50deg. C. or 90deg. F. above the atmosphere; so that we deduce the following formula:

$$C = \sqrt{\left(\frac{\cdot 0003 \times 50 \times S}{\cdot 24\, R}\right)} = \cdot 25 \sqrt{\frac{S}{R}}$$

Expressing the exposed surface in square inches, we have $C = \cdot 64 \sqrt{\frac{S}{R}}$

Current density is expressed as so many amperes per square inch, and we will apply this last approximate rule to see what current density it gives. A wire to have one square inch of cross-sectional area must have a diameter of a little over 1⅛in., and the circumference will be [illegible] × 3·1416 = 3·543 in. Assume the wire is 200ft. long, therefore the cylindrical exposed surface will be 2,400 × 3·543 = 8,563 square inches, and the resistance in ohms at 50deg. C. above the atmosphere may be put down roughly at ·002. Inserting our values, we have

$$C = \cdot 64 \sqrt{\frac{8{,}563}{\cdot 002}} = 1{,}324 \text{ amperes.}$$

Hence, in order that the wire shall not heat up more than 50deg. C. or 90deg. F. above the temperature of the atmosphere, the current must not be more than about 1,[illegible] amperes for a conductor having one square inch area.

When the same amount of current flows through wires of different diameters, the temperature of the wire is inversely proportional to the fourth power of the diameter, because halving the diameter of a wire gives

times the resistance, and since the current remains constant, this means four times the heating effect; second, the mass is now only one-fourth of what it was previously, therefore we have four times the heat spent on one-fourth of the mass, so that its temperature will be sixteen times as much. Expressed in symbols, this law is $T \propto \frac{1}{D^4}$, where T equals temperature and D equals diameter.

(To be continued.)

SIGNALLING AND SPEAKING BY MEANS OF ELECTRICAL CURRENTS WITHOUT WIRES.

BY SYDNEY F. WALKER.

As a considerable amount of interest is being taken in the above at the present time, following on the article recently published in the *Times* dealing with Mr. Preece's and Mr. Gavey's experiments between the mainland and the Flat Holmes, an island in the Bristol Channel, it may perhaps be of service if the writer describes some experiments he has made in the same direction, and if he details the principles, as he understands them, on which work of this kind has to be conducted if it is to be successful.

The writer began to study this question some years since, and he has worked at it intermittently when time could be snatched from other work. He has succeeded not only in transmitting signals by the Morse code, using a magneto telephone as a receiver, but he has also succeeded in transmitting audible speech, spoken words, across a body of water without any other conductor except the intervening water, and under conditions that render it apparent that the transmission of speech across large bodies of water, within certain limits, is merely a matter of calculation.

The object the writer had in view in taking up the question was not the connection of lighthouses with the shore, but the transmission of signals, and of speech between ships at sea and between ships and the shore.

Eight years of the writer's young life having been spent as a midshipman and sub-lieutenant in her Majesty's service, he has been struck with the enormous advantage that would accrue to ships of all kinds if some reliable means of communication could be established between ships and the shore, or between individual ships at sea, that would be independent of the weather. He has a lively recollection of keeping a middle watch on the bridge of a man-of-war, creeping round the English and Irish coasts in a dense fog, or on a night so thick that one could hardly see two yards from the ship. If under such circumstances one could speak to the shore, and to any ship within a certain radius, the chances of collision and of shipwreck would be very considerably reduced.

The principles, however, upon which communication is established between ships and between ships and the shore are equally applicable to communication across large bodies of waters, such as the estuaries of our large rivers; and even, it appears to the writer, under favourable conditions, across large masses of the earth's crust, such, for instance, as from the surface of a mine to the working face.

In approaching the subject, which he has considered from all points, it has appeared to the writer that *conduction*, and not *induction*, should be the method employed in work of the kind under notice. One cannot, of course, have conduction without also creating inductive phenomena; but the writer's view is that conductive phenomena should be made use of, inductive phenomena being either guarded against or accepted, as they turn for or against the result sought for. It will be found, the writer believes, that inductive phenomena in the cases referred to assist the results obtained by conduction. The lines upon which the writer has worked are as follows:

If a conducting mass be taken—say, a cubical block of copper—and a source of electricity be connected, say, to two adjacent corners of the mass, the current which results will pass not only by way of the near face of the mass, but also through every other portion of the mass, passing in curves of smaller and smaller radius as the paths recede from the near face. Similarly, if the source of electricity be applied to two planes near the centre of the copper mass, the current would pass, not only across the mass by the shortest path, but also in curved paths on each side of this centre line.

Now, this being so, it follows that there will be a regular fall of electrical potential along each of the paths open to the current, and therefore that if connection be made at any two points in any one or more of these paths by a conductor which is connected with some apparatus that will denote the presence of a current of electricity, a current will pass through the apparatus and will work the apparatus—if the latter is sufficiently sensitive to respond to the current that will pass, in obedience to the E.M.F. present between the two points.

That is to say, supposing an E.M.F. of $\frac{1}{100}$ volt to be present between any two points in the conducting mass before referred to, and an apparatus, such as a telephone receiver, be connected to these two points, a click will be heard in the telephone, whenever either the local circuit in which the receiver is connected is made or broken, or when the circuit in which the generator is connected is made or broken, or its E.M.F. is varied sufficiently. Let the conducting mass be a body of water instead of a cable of copper, and let connection be made to the water by plates immersed in it, the plates being connected to a generator of electricity. It should follow, as the writer has proved it does follow, that if a second pair of connections be made with the body of water by means of a second pair of plates immersed in it, an E.M.F. will be present between these two plates which will cause a current of electricity to pass through any apparatus—such as a magneto-telephone receiver—that may be connected to them. And if this circuit can be made and broken, or the E.M.F. at its terminal plates sufficiently varied, the telephone will furnish audible evidence of the fact, and can therefore be used for the transmission of signals or of speech; provided that the initial E.M.F. present at the terminal plates to which it is connected equals that to which the instrument responds. But here, in the writer's opinion, we come upon the fundamental principle of the whole thing. A very powerful current may be delivered to a body of water by means of immersed plates, and yet it may not be possible to get the faintest sign of a current in a telephone connected to two other immersed plates. Putting the matter one step back, it is quite possible to apply a very powerful E.M.F. to such a conductor as a body of water, and yet to lose all trace of it at a comparatively short distance from the plates which are connected to the generator; while, on the other hand, according to the writer's experiments, it is perfectly possible to get signals and speech at some distance off. What, then, are the conditions of success? To answer this question, we have only to ask ourselves how we can lose an E.M.F. Only by using it up. And how can we use up an E.M.F.? Only by either the creation of an opposing E.M.F., or by allowing it to drive a current through a resistance, the product of the current and resistance being equal to the E.M.F. disposed of. If we force a current of 10 amperes through a resistance of 10 ohms, we use up an E.M.F. of 100 volts, and we shall find no trace of E.M.F. beyond the limit of the 10 ohms so long as the 10 amperes are passing.

We have a striking instance of this in the shunt-wound dynamo, another in the E.M.F. of a primary battery when furnishing a current. In order, then, that we may not use up our available E.M.F. before reaching the points from which we wish to take a current through our telephone receiver, we must arrange that the product of $C \times R$ up to those points does not equal the total E.M.F. originally at our disposal. And this is to be done by making both the E.M.F. and the internal resistance of the generator used very low, and, as far as we are able, the resistances of the paths leading to the plates connected with our receiver also low. A generator having an E.M.F. of 100 volts, and an internal resistance of ·1 ohm would, if wound for an E.M.F. of only one volt, probably have an internal resistance of only ·001 ohm.

Now, in dealing with this question, we have to remember that, no matter what arrangements we make for our connection with the water, whether we bury our plates in

ground on shore, or immerse them in the water; whether we make our plates large or small, the resistance of the paths open to the current, once it reaches the water, must be very low indeed, as these paths comprise the whole body of the water, and will stretch away from the first connections in all directions.

If, then, the initial E.M.F. of our generator is high, and its internal resistance is also comparatively high, the large current which must pass into the water, unless the E.M.F. has been reduced before it reaches the water, will absorb the whole of the available E.M.F. by reason of the charge made by the internal resistance for the passage of the current. Taking the figures given above, and supposing the aggregate resistance offered by all the paths between the two generator plates, those connected to the generator, be ·01 ohm, as may very easily be, the current passing out from the generator would be $\frac{100}{\cdot 01}$ amperes = 10,000, and this would absorb considerably more than the E.M.F. available. Even if the resistance of the water paths was as much as ·1 ohm, the current passing would be 1,000, which would bring the E.M.F. at the plates to nil. Of course, in the first case the current mentioned would not pass, because the E.M.F. would be used up long before it reached that figure. The result would be the same, though, so far as picking up a current at the telephone plates was concerned. With the other winding furnishing one volt and with an internal resistance of ·001 ohm, the current passing where the aggregate resistance between the generator plates was ·01 ohm would be 100 amperes, and as this would only involve a charge of 1 volt, there would be ·9 volt left between the generator plates to send a current on to the receiver plates.

The writer has measured the E.M.F. required at the terminals of one of the watch magneto telephone receivers now in common use, and he makes it $\frac{1}{1000}$ volt. So that, assuming the figures given above, the resistance of the circuit formed by the two generator plates and the two receiver plates, passing from one generator plate to one receiver plate, thence to the other receiver plate and thence back to the second generator plate, may be very considerable before signals are lost. And as the variation of E.M.F. required for transmitting speech is even less than that required for signalling by the Morse code, the resistance of this circuit may be even greater for speech than for signals. This means that the larger the generator and receiver plates are made, provided the resistance of the generator and its connections to the receiver are sufficiently low, the farther may signals or speech be transmitted.

It should be thoroughly understood in connection with this matter that once the current passing through the remainder of the water, or whatever other paths may be open, is provided for, this path from the generator plates to the receiver plates acts quite independently of all the other paths, and will transmit its current to the receiver, just as if it had been an insulated wire lying in the water. Electromagnetic induction will, of course, be present, but, as before remarked, this will aid the desired result.

It follows, as a natural consequence, that the farther the generator plates are apart, the farther may signals and speech be transmitted, and also the farther apart the receiver plates can be placed, the farther can speech and signals be transmitted.

For a given size and distance between the receiver plates, the distance at which signals and speech can be received will depend inversely upon the resistance of the generator, and directly upon the size of the generator plates and their distance apart. It follows, also as a natural consequence, that the better conductor the liquid is, the shorter the distance to which speech and signals can be transmitted, other conditions being alike. The distance is greater in fresh water than in salt water, and in absolutely pure water it is at its best.

It also follows, from the above, that the presence of a metal conductor, such as the body of an iron ship, tends to reduce the distance, but this is only as the limit of the particular generator is reached. With a generator of very low resistance the iron body of the ship does not affect the result till a long distance is reached. The writer's plan for communications with ships, either from other ships or the shore, is to place on board the ship a dynamo of low voltage and very low resistance, connecting it by conductors of low resistance with copper plates at the bow and stern, the plates being insulated from the body of the ship. On shore, as already indicated, would be another pair of plates, these being, in fact, arranged in pairs all round the coast, connected by conductors of low resistance to a generator similar to those used on board the ships. Signalling or speech is effected by means of a sending key, or a microphone transmitter and induction coil, arranged as a shunt to the generator plates, its resistance of course being such that it can only take the current it can make use of. By either of these methods the required variations in E.M.F. are communicated to the generator plates, and from them to the receiver plates. It follows, of course, that by this arrangement each pair of generator plates are also receiver plates and [illegible] the receiving telephone being connected to the [illegible] either as another derivation or in series with the secondary of the induction coil, as most convenient.

The question of calling attention has, of course, to be dealt with. In the writer's opinion this will not be difficult. On board ship and at look-out stations on shore men can be constantly listening at the telephone [illegible] greater inconvenience than the regular look-out man now suffers. The writer believes, too, that it would be practicable to arrange a relay worked by a subsidiary telephone to make the connection of a local circuit in which a bell and battery were included in the ordinary way, or [illegible] another derivation from the generator. The problem of using delicate telephonic apparatus on board ship is more serious, on account of the difficulty of keeping the connections in order. That difficulty, however, could be overcome, in the writer's opinion, by giving increased wearing [illegible] to the connecting portions of the apparatus, by teaching seamen the principles upon which the apparatus is [illegible] and by giving them plenty of spare parts to take [illegible] with them.

One other difficulty remains to be dealt with, so far as the writer has gone at present—viz., the effect of storm waves. He has tested this as far as can be done on a limited scale, and he finds, as might be expected, that the effect is to produce a continuous crackling in the telephone receiver, similar to that produced by telegraphic [illegible] in wires running on the same poles with unbalanced telephone wires. This would appear to indicate that speech [illegible] be more difficult in stormy weather, but not impossible.

OBITUARY.

THE LATE DR. WERNER SIEMENS.

We regret to record the death of Dr. Werner Siemens, which took place on Tuesday last. The name of Siemens is familiar to English ears; in fact, we are almost in the habit of looking upon the firm as an English firm. This may not be quite correct, but so intimately is the English branch welded into our industrial edifice, and so intimately is the name of Siemens connected with our steel manufacture, with electric lighting and power and cable enterprise, that we may claim it as indigenous to the soil. The late Dr. W. Siemens was the first representative of the firm here, worthily followed by Mr. A. Siemens. The late Dr. Werner Siemens was, we believe, principally resident in Berlin, and represented what might be termed the [illegible] actor of the firm. He was born in 1816 at Lenthe, near Hanover, and educated at the Lubeck Gymnasium. He entered the army, gaining the rank of lieutenant in 1837, but while engaged in military duties his studies were devoted to scientific subjects, and he took out a number of patents for various inventions. As a member of a commission of the Prussian General Staff for the introduction of the electric telegraph system in place of the optical telegraphs, he proposed in 1847, the application of subterranean conductors insulated by guttapercha, and executed successfully experimental lines coated with guttapercha by means of a press invented by him for that purpose, which is still used in the manu[illegible]

facture of cables. With the help of these insulated wires he succeeded in laying, together with Prof. Himly, the first submarine mines with electric ignition in the spring of 1848, for the protection of the harbour of Kiel from the Danish fleet. In the same year he carried out the first great telegraph line in Germany between Berlin and Frankfort-on-the-Main, and in the following year the subterranean line between Berlin and Cologne. Dr. Siemens left Government service in 1850, and devoted himself afterwards entirely to scientific studies and private enterprises. In 1847 he had already laid the foundation of the telegraph works, carried on afterwards by him under the firm of Siemens and Halske in Berlin. Six of the existing Atlantic cables, as well as many others, were laid by Messrs. Siemens Brothers, to the formation of which company Dr. Siemens greatly contributed. Dr. Siemens was the inventor of the pneumatic tube system and several important improvements in dynamos, and was an honorary member of the British Association and of most of the European electrical and scientific societies. In 1886 Dr. Siemens presented 500,000 marks to the German nation for the foundation of a national scientific and technical institution. In 1888 he was ennobled, and in the same year he published a collection of scientific treatises. The degree of Ph.D. was conferred on him by Berlin University in 1874.

INSTITUTION OF ELECTRICAL ENGINEERS, Dec. 8.

Prof. W. E. Ayrton, F.R.S., in the chair.

The annual general meeting was held at the Institution of Civil Engineers, when the minutes of the last meeting were duly received and confirmed.

Mr. Thomas Joseph Gough, 159, Church-lane, Gorton, Manchester, was balloted for and duly elected as an associate.

The **President** referred to the loss the Institution had sustained in the death of Dr. Werner Siemens, who was perhaps the most famous o the famed band of brothers. His wide study of science could be best seen by an examination of the memoirs so recently published, and of which one volume was translated into English. There was a leading thought through these memoirs to show how a boy, starting with no particular privileges, could reach into the highest ranks of science. He concluded by proposing a vote of condolence and sympathy to the widow and family of Dr. Werner Siemens.

Prof. Forbes seconded the vote, which was carried unanimously.

The **Secretary** then read the annual report of the Council, which stated that the number of members elected during the year was fewer than the number elected last year, for reasons well known, as the new regulations came into operation in January last, and many men were elected last year who would in the ordinary course have been elected this year. Still the number was above the average, being nine honorary members, 12 members, 101 associates, and 98 students. During the year the Society had lost 22 members by death. Of the papers read during the year the premiums had been awarded as follows:

Institution Premium, £10, to Mr. Nikola Tesla.
Paris Exhibition Premium, £5, to Mr. Reckenzaun.
Fahie Premium, £5, to Messrs. Heaviside and Jackson.
The Salomons Scholarship had been awarded to Mr. Woodhouse, of the Central Institution.

Reference was made to the Chicago Exhibition, and the apathy shown by English manufacturers to exhibit there. The Institution had sent out an appeal trying to get a representative collection of apparatus under one exhibit, but still the manufacturers held aloof, and made no response to the appeal; hence the effort to obtain such an exhibit had to be abandoned. The finances of the Institution were satisfactory. An index to the volumes of the *Proceedings* has been compiled, and will be ready in a week or two.

The **President** moved, and **Mr. Stroh** seconded, the adoption of the report, which was carried after a discussion as to the present method of electing associates, brought forward by **Mr. Trotter**, who thought the present method needed alteration. General Webber, Sir D. Salomons, and several members made remarks, but ultimately the question was left in the hands of the Council.

General Webber moved and **Mr. Mordey** seconded a resolution of cordial thanks to the Institution of Civil Engineers for the use of the hall in which the meetings of the Institution of Electrical Engineers was held. The President and Council of the Institution of Civil Engineers had shown great kindness and consideration for the welfare of the Institution in so granting the hall, not only for the scheduled meetings but for the many supplementary meetings the plethora of papers and lengthy discussions necessitated. The resolution was carried unanimously.

Sir David Salomons moved and **Prof. Hughes** seconded a vote of thanks to the local honorary secretaries, of whom three had been lost by death during the year—viz., those of Japan, Norway, and Germany. The resolution was carried unanimously.

Mr. Swinburne moved a vote of thanks to the honorary auditors, Messrs. Danvers and Stroh, to which **Mr. Stroh** returned thanks for his colleague and himself.

Mr. Crompton moved, and **Prof. Fleming** seconded, a vote of thanks to the honorary solicitors, which was carried unanimously.

The discussion on Dr. Fleming's paper was resumed by **Mr. Mordey**, who desired to speak at length only upon one point in the paper—the sudden rush of magnetising current into the transformer, mentioned towards the end of the paper. In the first place, however, he would refer to the question of loss in the iron, a subject with which his name had been freely connected, but he had really nothing fresh to say in the matter. His original investigations were brought before the Institution and corroborated in two series of experiments by Prof. Ayrton, but in a third series of experiments Prof. Ayrton had failed to find the effect, so that his corroboration might be said to be cancelled. The speaker stated his intention to resume the experiments as opportunity offered, and if he found his previous results wrong, would come before the Institution and make a clear breast of the matter. He was highly amused at anonymous people hiding themselves behind leaderettes, and speaking of his results as contrary to "Nature's laws." He did not understand "Nature's laws," but these people did, and infallibly knew all about the behaviour of iron under all circumstances. However, he quoted a sentence from a letter of Prof. Ewing, an investigator who had paid more attention to this subject than any man of them or all of them put together, in which Prof. Ewing thought that his (Mr. Mordey's) results were in accordance with molecular theory. The speaker then went on to say that since the reading of Prof. Fleming's interesting paper he had carried out several series of experiments on the question of the rush of current into the transformer. At first he thought that it was a capacity effect, but his experiments had proved conclusively that it was not so, and that the views of Dr. Fleming on this point were correct. A large number of contacts with different transformers at frequencies of 83 and 100 showed the effect was greater at lower frequencies. It was greater when the break was very quick, when the magnetic effect had not time to die away. With a slow break it did not happen. Contrary to Dr. Fleming's remarks he found it occurred both ways of transforming. He found it was not a current effect but a magnetic effect, and did not occur in both circuits. Exciting by secondary cells in the same direction a lamp became brilliant in 1 or 1½ seconds, in opposite direction four or five seconds. Elphinstone and Vincent had alluded to residual effect in 1880, showing a magnet with single cell supporting 1lb., when disconnected could be gradually loaded up to carry 50 ounces.

Mr. Crompton, after alluding to his experience, said transformer distribution had not reached the figure he had given years ago, though direct current had. Transformer engineers did not know yet the losses in primary, much more secondary wires. The ideal coal per unit was 3·7lb., best results by low tension 6·4lb., but by alternating it was still 16lb., two-thirds the loss going in transformers. With average private house load a Mordey transformer gave 49.5 per cent., and Westinghouse 54·5. Stations had a load factor of 10 to 14, and houses two to three; large substations might approach the former, but would be usually about 7 per cent. With the best results given by Dr. Fleming, the annual efficiency could not rise above 80 per cent., but if the paper elevated the efficiency from 50 to 80 per cent. it would have given great gain.

Dr. Sumpner said the wattmeter method of testing was the more practical of the two proposed. The explanation of the wattmeter effect had been really pointed out by Dr. Fleming six years—the lag of eddy currents in a suspended plate.

The discussion was adjourned to next January.

Mr. W. H. Preece was announced as President for the ensuing year, the list of officers being as given in our last.

ELECTRIC LIGHTING PROVISIONAL ORDERS, SESSION 1893.

GAZETTE NOTICES AND MAPS DEPOSITED AT THE BOARD OF TRADE ON OR BEFORE THE 30th NOVEMBER LAST.

Name of town, parish, or district.	Local authority or company applying.
Altrincham and Bowdon...	Manchester Edison-Swan Co., Ltd.
Barnet	Local Board.
Beckenham	Urban Sanitary Authority.
Bridgend	Local Board
Brighton	Brighton and Hove Electric Light Co., Ltd.
Colchester	Corporation
Eccles	,,
County of London—	
Hackney	Hackney District Board of Works.
Hammersmith	Vestry.
Islington	,,
,,	County of London Electric Lighting Co., Ltd.
,, (North)	Holloway Electricity Supply Co., Ltd.
Poplar	Poplar District Board of Works.
Newcastle-upon-Tyne	Newcastle-upon-Tyne Electric Supply Co., Ltd.
Newmarket	British Electric Light Co., Ltd.
Partick	Commissioners of Police.
Reading	Reading Electric Supply Co., Ltd.
Taunton	Corporation.

THE

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CONTENTS.

TO CORRESPONDENTS.

 Secretaries and Managers of Companies are invited to furnish notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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Apprentice.—*Letters are awaiting you at our office.*

A PLAUSIBLE SCHEME.

By terming the scheme which Mr. Thwaite has proposed in his paper to the Manchester Association of Engineers a plausible scheme, we intend no disparagement, but rather desire to indicate that it is a very taking project. From the earliest development of electric lighting in the eighties the idea has periodically been expressed that *the* proper way to obtain electrical energy in our large towns was to generate it at the coalfields, and from thence conduct it to the points required. If our memory serves us correctly, Prof. Perry rather made a hobby of such a project, contending that the economy of the large engines that might be used, and the low price of fuel, would make such a scheme, when carried out in practice, a paying concern. Mr. Ferranti, too, was evidently of a similar opinion when he designed the Deptford station. Certainly he did not go to the coalfields, but his aim was large units, the most economical large engines, and a point where coal could be cheaply placed in the bunkers of the boiler-room. Mr. Thwaite argues in favour of gas engines of large power, and many men agree with him. Theoretically, we believe, most men agree with him, but, practically, they shirk putting entire faith in gas engines of large calibre because they have not been extensively tried. It is all very well to say that compound gas engines of 1,000 i.h.p. can now be had for the ordering, but before a buyer risks his money he wants to know where such engines are to be seen, how long they have been running, and the practical results of such running. We have no word to say against the possibilities of such engines, but the general public before they contribute to share capital will require satisfactory answers to such questions as those we have indicated. Assuming, however, that either gas engines of the size required are thoroughly reliable, or that steam engines would be used, the scheme presents no grave difficulties. Long-distance transmission has not the same terrors it formerly had. We are becoming more and more accustomed to consider larger and larger works, till 50 miles more or less are taken to mean simply so much more initial cost for mains and an annual loss of pressure which can soon be calculated. It is evident that the Lauffen transmission experiment gave the impetus to Mr. Thwaite, in that his estimates for plant are derived from foreign sources, from the men, in fact, who had experience during the Lauffen-Frankfort experiment. These estimates are really very moderate when the whole scheme is considered, as will be seen when the conclusion of the paper is given next week. We may, however, now say that three principal generating stations are proposed—one to supply Manchester and the Ship Canal, Blackburn, Bolton, Preston, Liverpool, Oldham, Chorley, Ashton, Stockport, Warrington, St. Helens, Runcorn, Widnes, Heywood, Burnley, Bury, Rochdale; the second to supply Leeds, Sheffield, Bradford, Halifax, Huddersfield, Wakefield, Dewsbury, Rotherham, Stalybridge; and the third to supply 1, Mansfield; 2, Nottingham; 3, Derby; 4, Melton Mowbray; 5, Leicester; 6, Market Harborough; 7, Kettering; 8, Northampton; 9, Bedford. 10

Hitchen; 11, Luton; 12, St. Albans; 13, Greater London; 20, Wolverhampton; 21, Birmingham; with a stand-by, or second station, in the last case in the Staffordshire district. The estimates for providing engines, dynamos, switchboards, transformers, and trunk mains are, respectively, £340,000 and £334,800 for a 10,000-h.p. transmission plant, the generating station being at the Yorkshire coalfields, some 120 miles away from the metropolis, while the estimated receipts are sufficient to warrant an expenditure of half a million. It is always a dangerous matter to estimate receipts and time of full load, as in these directions the author is apt to look very favourably upon figures. Further, the expenditure is only for a part of the necessary equipment of a company. Nevertheless, the scheme is one that commends itself for close examination, and no doubt there will be ere long an effort made, not perhaps to carry out this scheme in its entirety, but to establish a central station on a coalfield, and from thence to supply the towns within a radius of twenty or thirty miles.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RE FIRE AT LONDON STEREOSCOPIC COMPANY, REGENT STREET.

SIR,—My attention has been called to a letter published in the last issue of one of your contemporaries signed by "J. D. F. Andrews."

The statement he makes therein—that I examined and passed the electrical installation at the London Stereoscopic Company's premises—contains not a single word of truth. I knew nothing whatever about the installation, nor were any of the insurances effected in the Phœnix Fire Office.

With regard to Scott's Oyster Rooms, I never saw the installation, nor was I even aware that the electric light was in the premises. Neither was the Phœnix Fire Office aware that there was any electrical installation, the work having been placed up some years ago, when the premises were insured in another fire office. As to whether there is the slightest justification in laying the charge of the fire to electricity, I leave those concerned to say if they think it worth their while.

I must request you to publish this letter, as the false and misleading manner in which Mr. J. D. F. Andrews has made use of my name makes me depart from my rule of passing unheeded erroneous or unjust statements in print with regard to myself or work.—Yours, etc.,

December 6, 1892. MUSGRAVE HEAPHY.

PRICE OF ELECTRIC SUPPLY.

SIR,—In reference to Dr. Hopkinson's proposed method of charging for electricity in Manchester, I believe I may claim to have been the first to suggest a scale of charges depending on the maximum current demanded by a consumer.

The schedule of prices for the electric lighting license granted to the Liverpool Electric Supply Company in 1888 contained a sliding scale of charges per quarter, which may be shortly expressed as follows:

1. For any number of units up to 100 times the number of units per hour of maximum demanded supply, 1s. per unit.
2. For any further quantity up to 100 times the maximum demanded supply per hour, 8d. per unit.
3. For any further quantity, 4d. per unit.

For example, a consumer demanding a maximum supply of three units per hour, and having used 1,100 units in a quarter, would be charged the following rates: 300 units at 1s., 300 units at 8d., and the balance of 500 units at 4d.

It was found, however, that the consumers had some difficulty in understanding the scale, being accustomed to the sweet simplicity of the uniform rate charged by the local gas company, and that dissatisfaction was always expressed by consumers who used their lamps only a small number of hours, and therefore never reached the lower rates.

All sliding charges based on the maximum demanded supply have the serious disadvantage of limiting the number of lamps fitted up by a consumer to the smallest number he can possibly do with, thus preventing the adoption of the light in positions where the lamps are only occasionally required.

A sliding scale is also an obstacle to the introduction of the light in buildings not often used, and especially churches, which are valuable customers to a supply company on account of only requiring a supply on Sundays, when the central station load is at a minimum.

Four years' trial of the above method of charging in Liverpool proved that its disadvantages were greater than its advantages, and, consequently, in the Liverpool Electric Lighting Order of 1892, the sliding scale was repealed and a uniform rate of charges substituted.

The present price charged in Liverpool is 7½d. per unit, or about double the price of gas, and with a rapidly-increasing demand for electric light and the more efficient and cheaper incandescent lamps that may be expected when the present oppressive monopoly in lamps comes to an end next year, the day is not far distant when the electric light will, in addition to its many advantages, be, light for light, as cheap as gas.

A uniform rate has been found to answer well in the case of the greater number of gas and water companies, and is equally suitable for electric supply companies when the circumstances permit of a reasonably low price being charged.—Yours, etc., A. BROMLEY HOLMES.

Liverpool, December 5th, 1892.

VARLEY TESTIMONIAL.

SIR,—We shall be glad if you will allow us the opportunity of calling the attention of your readers who are interested in the above to the fact that although we have received encouraging responses and subscriptions from some of those we expected to aid us, yet the response as a whole has up to the present been disappointing, more especially on the side of the manufacturing community. We are sure that it will be found in most cases that this is due to our circular letter of appeal having been overlooked, owing to its being sent out during the season when a good many members of the electrical profession were away on their holidays.

The object of this letter is to remind them and all others who have benefited by the undoubted impulse which Varley's inventions gave to electrical engineering to send in, without further delay, their subscriptions, according to their means, to Mr. A. Stroh, 98, Haverstock-hill, N.W., endorsing subscriptions to Varley testimonial fund.—Yours, etc.,

A. STROH, Hon. Treasurer.
R. E. CROMPTON, Hon. Secretary.

SUPPLEMENTARY REPORT OF THE ELECTRICAL STANDARDS COMMITTEE.

To the Right Hon. A. J. Mundella, M.P., President of the Board of Trade.

Subsequently to the presentation of our former report to Sir Michael Hicks-Beach in July, 1891, we were informed that it was probable that the German Government would shortly take steps to establish legal standards for use in connection with electrical supply, and that, with a view to secure complete agreement between the proposed standards in Germany and England, the director of the Physico-Technical Imperial Institute at Berlin, Prof. von Helmholtz, with certain of his assistants, proposed to visit England for the purpose of making exact comparisons

between the units in use in the two countries, and of attending the meeting of the British Association which was to take place in August in Edinburgh.

Having regard to the importance of this communication, it appeared desirable that the Board of Trade should postpone the action recommended in our previous report until after Prof. Helmholtz's visit.

That visit took place early in August, and there was a very full discussion of the whole subject at the meeting of the British Association in Edinburgh, at which several of our number were present. The meeting was also attended by Dr. Guillaume, of the Bureau International des Poids et Mesures, and Prof. Carhart, of the University of Michigan, U.S.A., who were well qualified by their scientific attainments to represent the opinion of their respective countries.

It appeared from the discussion that a few comparatively slight modifications of the resolution included in our previous report would tend to secure international agreement.

An extract from the report of the Electrical Standards Committee of the British Association embodying the results of this discussion was communicated to us by the secretary, and will be found in the appendix to this report.

Having carefully reconsidered the whole question in view of this communication, and having received the report of the sub-committee mentioned in resolution 14 of our previous report, we now desire, for the resolutions contained in that report, to substitute the following:

RESOLUTIONS.

1. That it is desirable that new denominations of standards for the measurement of electricity should be made and approved by her Majesty in Council as Board of Trade standards.

2. That the magnitudes of these standards should be determined on the electromagnetic system of measurement with reference to the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time, and that by the terms centimetre and gramme are meant the standards of those denominations deposited with the Board of Trade.

3. That the standard of electrical resistance should be denominated the ohm, and should have the value 1,000,000,000 in terms of the centimetre and second.

4. That the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in a mass of a constant cross-sectional area, and of a length of 106·3 centimetres may be adopted as one ohm.

5. That a material standard, constructed in solid metal, should be adopted as the standard ohm, and should from time to time be verified by comparison with a column of mercury of known dimensions.

6. That for the purpose of replacing the standard, if lost, destroyed, or damaged, and for ordinary use, a limited number of copies should be constructed, which should be periodically compared with the standard ohm.

7. That resistances constructed in solid metal should be adopted as Board of Trade standards for multiples and sub-multiples of the ohm.

8. That the value of the standard of resistance constructed by a committee of the British Association for the Advancement of Science in the years 1863 and 1864, and known as the British Association unit, may be taken as ·9866 of the ohm.

9. That the standard of electrical current should be denominated the ampere, and should have the value one-tenth (0·1) in terms of the centimetre, gramme, and second.

10. That an unvarying current which, when passed through a solution of nitrate of silver in water, in accordance with the specification attached to this report, deposits silver at the rate of 0·001118 of a gramme per second may be taken as a current of one ampere.

11. That an alternating current of one ampere shall mean a current such that the square root of the time-average of the square of its strength at each instant in amperes is unity.

12. That instruments constructed on the principle of the balance, in which by the proper disposition of the conductors, forces of attraction and repulsion are produced, which depend upon the amount of current passing, and are balanced by known weights, should be adopted as the Board of Trade standards for the measurement of current whether unvarying or alternating.

13. That the standard of electrical pressure should be denominated the volt, being the pressure which, if steadily applied to a conductor whose resistance is one ohm, will produce a current of one ampere.

14. That the electrical pressure at a temperature of 15deg. centigrade between the poles or electrodes of the voltaic cell known as Clark's cell, prepared in accordance with the specification attached to this report, may be taken as not differing from a pressure of 1·434 volts, by more than one part in one thousand.

15. That an alternating pressure of one volt shall mean a pressure such that the square root of the time average of the square of its value at each instant in volts is unity.

16. That instruments constructed on the principle of Lord Kelvin's quadrant electrometer used idiostatically, and, for high pressures, instruments on the principle of the balance, electrostatic forces being balanced against a known weight, should be adopted as Board of Trade standards for the measurement of pressure, whether unvarying or alternating.

(Signed) COURTENAY BOYLE. RAYLEIGH.
KELVIN. G. CAREY FOSTER.
P. CARDEW. R. T. GLAZEBROOK.
W. H. PREECE. J. HOPKINSON.
W. E. AYRTON.

(Signed) T. W. P. BLOMEFIELD, Secretary.

29th November, 1892.

SPECIFICATION REFERRED TO IN RESOLUTION 10.

In the following specification the term silver voltameter means the arrangement of apparatus by means of which an electric current is passed through a solution of nitrate of silver in water. The silver voltameter measures the total electrical quantity which has passed during the time of the experiment, and by noting this time the time average of the current, or if the current has been kept constant, the current itself, can be deduced.

In employing the silver voltameter to measure currents of about one ampere the following arrangements should be adopted. The cathode on which the silver is to be deposited should take the form of a platinum bowl not less than 10 cm. in diameter, and from 4 cm. to 5 cm. in depth.

The anode should be a plate of pure silver some 30 square cm. in area and two or three millimetres in thickness.

This is supported horizontally in the liquid near the top of the solution by a platinum wire passed through holes in the plate at opposite corners. To prevent the disintegrated silver which is formed on the anode from falling on to the cathode, the anode should be wrapped round with pure filter paper, secured at the back with sealing wax.

The liquid should consist of a neutral solution of pure silver nitrate, containing about 15 parts by weight of the nitrate to 85 parts of water.

The resistance of the voltameter changes somewhat as the current passes. To prevent these changes having too great an effect on the current, some resistance besides that of the voltameter should be inserted in the circuit. The total metallic resistance of the circuit should not be less than 10 ohms.

METHOD OF MAKING A MEASUREMENT.

The platinum bowl is washed with nitric acid and distilled water, dried by heat, and then left to cool in a desiccator. When thoroughly dry it is weighed carefully.

It is nearly filled with the solution, and connected to the rest of the circuit by being placed on a clean copper support to which a binding screw is attached. This copper support must be insulated.

The anode is then immersed in the solution so as to be well covered by it and supported in that position; the connections to the rest of the circuit are made.

Contact is made at the key, noting the time of contact. The current is allowed to pass for not less than half an hour, and the time at which contact is broken is observed. Care must be taken that the clock used is keeping correct time during this interval.

The solution is now removed from the bowl and the deposit is washed with distilled water and left to soak for at least six hours. It is then rinsed successively with distilled water and absolute alcohol and dried in a hot-air bath at a temperature of about 160deg. C. After cooling in a desiccator it is weighed again. The gain in weight gives the silver deposited.

To find the current in amperes, this weight, expressed in grammes, must be divided by the number of seconds during which the current has been passed, and by ·001118.

The result will be the time average of the current, if during the interval the current has varied.

In determining by this method the constant of an instrument the current should be kept as nearly constant as possible, and the readings of the instrument taken at frequent observed intervals of time. These observations give a curve from which the reading corresponding to the mean current—time-average of the current—can

ECONOMIC POSSIBILITIES OF THE GENERATION OF E.M.F. IN THE COALFIELDS, AND ITS APPLICATION TO INDUSTRIAL CENTRES.*

BY B. H. THWAITE, C.E.

The recent history of the useful development of the application of electric energy reads like some marvellous story emanating from the brain of an Oriental dreamer. An engineer loving his noble art has only to look into this history with thoughtful interest, to be drawn into the train of constantly increasing length of those who follow and proudly own allegiance to this fair goddess Electra. After all, the employment of electric energy for the uses of man is only another instance of the wisdom of imitating the economic ways of Nature. The entire organic system, whether plant or animal, is controlled and reared by this magic and mysterious force that, like the initiation of life, can neither be understood nor described. The sensible impressions of life and the movement of the muscles are merely the result of this electric energy, produced by the chemical actions set up by the introduction of nitrogenous and carbonaceous food elements into a solution of the gastric juice of the human system. The spinal column is the transformer, the brain is the switchboard, and the nerves the conductors to the distributed motor elements of the anatomical system. The modern development of applied electrical science is extending these vital methods of dynamic effort to the external areas around man, by which, in the instance of, in one example, the nervous impulses moving his tongue are transmitted miles away to be imparted by the telephonic apparatus to the tympanum or drum of the ear of another and listening man. The brain impulses, or thoughts enclosed in speech, are thus transmitted beyond oneself in Nature's ways, so that here we have the natural electric impulses lengthened by the skill of man to an almost indefinite extent, and adding to the convenience and resources of humanity in its fight for existence. The force created by the energy of man is also transmitted to far off distances, and now we have our country becoming gradually converted into a semblance of the human nervous system, a semblance that, as time flies on, will become greater and greater. What could be more appropriate than the location of the electric energy producing elements in positions appropriate for the acquirement of the highest efficiency and economy, and in its transmission to civilised industrial centres where the impulses of nervous energy direct and control the operations of supply and demand of the requirements for sustaining life and the comforts associated with it.

The onward rush of this marvellous electric energy has drawn by its power of attraction most of the workers in the field of applied science but the field of operation is so expansive, and so allied to the engineering art that no engineer should draw back from the attractive embrace of this mysterious force. Unlike the evolution of the use of steam, and the conception of the steam engine, which was practically developed by the genius of one inventive mind—that of James Watt—the minds of most of the intelligent physicists and mechanicians of all civilised nations on each side of the Atlantic have been concentrated in the work of advancing the application and widening the field of use of this fascinating form of energy. Manchester, the cradle of many of the great engineering developments, has, through Joule and Wilde, contributed her quota to this laudable effort, and to-day it may be truthfully asserted that no other practical or applied science has had, measured in terms of time, an equivalent success to that of the application of the science of electricity and its uses, and the resulting sum of the intelligence of the workmen in this field of science is the greatest proof we have of the broadly advancing intellect of humanity. No other applied science has, by time measurement, received the same degree of mathematical treatment. Whether the progress of practical development has been benefited by this associated analytic treatment (and its deducing value possible by this mathematical analysis) may be an open question. Mathematicians are generally more of analysts than synthesists. They rarely conceive or create, although in Lord Kelvin we have a brilliant exception, but this may only prove the rule. It has been asserted that no real progress was made in the development of electro generating machines until the law of progress indicated by purely mathematical reasoning had been ignored. Be this as it may, it can be proudly stated that the present elements constituting the electric generator—*i.e.*, the apparatus for raising and lowering the pressure of the electric energy to be distributed, its distribution and final employment at pressures of controllable limit in an averted or reversible type of electric machine, have been raised to an almost maximum possible degree of efficiency, at least eight times higher than the best of the high-class steam engines now constructed. Divested of mathematical treatment the active and essential principles underlying and controlling technical electro dynamics can be mastered by any ordinarily intelligent engineer to whose craft in a great measure will fall the future care and control of this mysterious electric force.

These remarks are prompted by a desire to direct the eyes of all engineers to the importance of studying and mastering the main principles underlying the construction and application of electric generators and the intra elements between it and the motor. They will find a fascinating field open before them, in which everyone may discover a furrow in which to plough for his own advantage and for the benefit of an expanding electro-technical science. Switzerland, thanks to her natural waterfall resources of the Alpine areas, is rapidly becoming an industrial centre of an importance, diversity, and magnitude far away beyond the dreams of the most ardent Swiss patriots. And this cheap and convenient power is inviting, with effect, the opening up by not only the Swiss republican citizens, but by strangers, of new and important industries, and to-day Switzerland may be said to annually produce the largest weight of aluminium of any country in the world. Our own carbonaceous fuel power resources have been one, if not the main, source of England's industrial greatness, but with the entrance of this new electric agent into the domain of practical engineering, the advantage we owe to our contiguity to the coal fields and to our possession of these fuel supply areas is being gradually undermined, and unless we utilise these resources so as to obtain the maximum practicable recovery efficiency from them by the aid and assistance of this wonderful electric agent, our industrial career will have another and serious retrogression.

Our coalfields have advantages that neither falling torrents of water, high tidal ranges, nor yet the force of wind currents possess. The supply of energy is constant, and does not depend upon the temperature of the one nor the barometric pressure and lunar dependence of the other.

Advantages of a Central Power Generating Station, or the Distribution of the Power from a Central Source.

The arguments that may be pertinently advanced in favour of a central power generating station are almost identical with those associated with the centralisation of a gas and water supply or a sewage treatment station, but the arguments are more adequate than those in favour of either of these examples. Assuming for a moment that the textile and other factories and workshops were all connected up with the power transmission mains carrying power generated at some large centralised power generating station. The factory owner would not then have the anxious responsibility of his power plant, involving the care of the [illegible] and unskilled labour element. The space absorbed by the steam boilers and economisers, engine house, coal stores, and chimney would not be required, and in towns this consideration might not be of unimportance. Then the troubles of coal and suitable water supply, and all the attendant requirements involved in the proper care and supervision of a steam engine plant would be avoided. The boiler insurance question would not trouble him. He would, in respect to his motive power supply, be as free from care as the proverbial jolly miller, whose power came from the winds of heaven or from the falls of rivulet and stream. The waste of fuel in early lighting and during meal hours would be avoided, and the excess of labour always associated with the conditions of isolated and comparatively small steam power plants would be saved. At the exact hour in the morning the mere movement of a switch throws the plant into operation, and at night the quick turn of a switch handle cuts off the power. The interest on the cost of the transmitting gear, the steam engine, the steam boilers, and the buildings during 14 hours out of the 24, which is at present lost would, by the supply of power from a central generating station, be avoided. The same main service, with the addition to the electromotor of a transformer, would be available for lighting purposes, for elevating goods and traversing them, and for ventilating, fire extinguishing, electrolytic, and innumerable other purposes. In the event of a decision to stop the factory for an indefinite period, there is no expensive staff to maintain the plant in a condition of efficiency. In deciding to stop the works or to disestablish them, the serious question always facing the owner of a steam engine and boiler plant—"of what shall I do with it?"—is met by the simple request to the staff at the central generating station to remove the electromotive power plant. This can be done without any trouble, and with little depreciation in the value of the machines. Whereas, who would lightly face the removal of a large steam engine, steam boiler, and economiser plant? not to mention the abandonment of the chimney and buildings. We all know the number of steam engine and boiler plants lying and rusting away at various abandoned or unlet works throughout the country, each plant having in its time the possibilities of useful work. The reduction of skilled labour required in proportion to the power produced that would follow the establishment of a coalfield [illegible] generating station, would be very great; in fact, this feature [illegible] justifies the correctness of the principle, on economic grounds, of the establishment of large central power generating stations. Another feature is the fact that an additional extension, [illegible] extra power plant, can easily be accomplished, whereas we all know how difficult in many instances it is to add [illegible] steam power plant simply owing to the exigencies of space and position. The compactness of the electric generator [illegible] permits it to be placed in positions absolutely [illegible] any other kind of power generating plant. Besides these advantages, there would be no [illegible] factory chimney [illegible] forth its smoke to poison the atmosphere and [illegible] the [illegible] natural laws involved in the [illegible] of energy.

Thanks to the commission appointed some years back by the Birmingham Corporation to report upon the [illegible] we are able to look through the matter of [illegible] of the existing system of power production and [illegible] few sentences their more important disadvantages. The [illegible] the only rule of that [illegible] their duty [illegible] testing a great number of engines in everyday work and varying in power from [illegible] The total [illegible] tion was ascertained, as well as incidental or [illegible] Owing to the extremely intermittent and varying [illegible] duty, the engines working under the most favourable [illegible] only averaged throughout the day one-third of their working capacity, but under the worst conditions only [illegible] the maximum capacity was utilised. The coal consumption in the most favoured examples was [illegible] lb. per indicated horse-power

* Paper read before the Manchester Association of Engineers.

per hour upon the average daily horse-power, and in the worst example the coal consumption attained the phenomenal one of 36lb. per indicated horse-power per hour. The commission carefully state that these results are not due to the imperfect construction of the engines, but are consequent on the varying character of the work required, and the necessity imposed upon each power user of maintaining a plant and steam engine equal to his maximum requirements. His motive power must be at hand and be available often at a moment's demand, and in the interim steam is blowing from and fuel is wasting at his boiler. The following advantages were accepted as belonging to any economic and effective method of distributing power to small users, and available for direct application to isolated machines: No heavy and costly foundation; no expensive shafting required; no smoke nuisance; no ashes or removal by cartage; cost of water and coal avoided; no danger from explosion; full power at any moment; only to pay for power in proportion to amount used. A municipal advantage would be the lessened coal traffic through the streets, and waste of the fuel *en route*.

As an illustration of the advantage of central supply plants in lieu of isolated ones, and which will be still further emphasised, practical standard of efficiency and satisfy the exigencies of duty is as follows:

1. The conversion of the solid fuel into a gaseous condition.

2. The abstraction of the nitrogenous value from the fuel, and its conversion into a condition suitable for agricultural fertilisation.

3. The direct combustion of such gaseous fuel in the combustion cylinder of a gas motor, for the conversion of the thermic into dynamic energy.

4. The transformation or transmutation of this dynamic into electric energy, or into E.M.F.

A diagram was shown which gave with approximate accuracy the apportionment of the thermic capital supplied by a gas or a steam engine and its allocation for useful, effective work, and the loss by unavoidable dispersion by conduction, sensible heat, and as unexpended thermo-chemical assets in the waste gases. The ultimate possible results of a fuel gas and gas motor plant on a large scale, is, that with such a plant, the dynamic power enclosed in the indicated card of pressure of a cylinder will be equivalent to the raising or elevation of 33·000lb. 1ft. high in one minute may be obtained with an expenditure of from ¾lb. to 1lb. of solid

ELECTRIC POWER TRANSMISSION FROM COAL FIELDS.

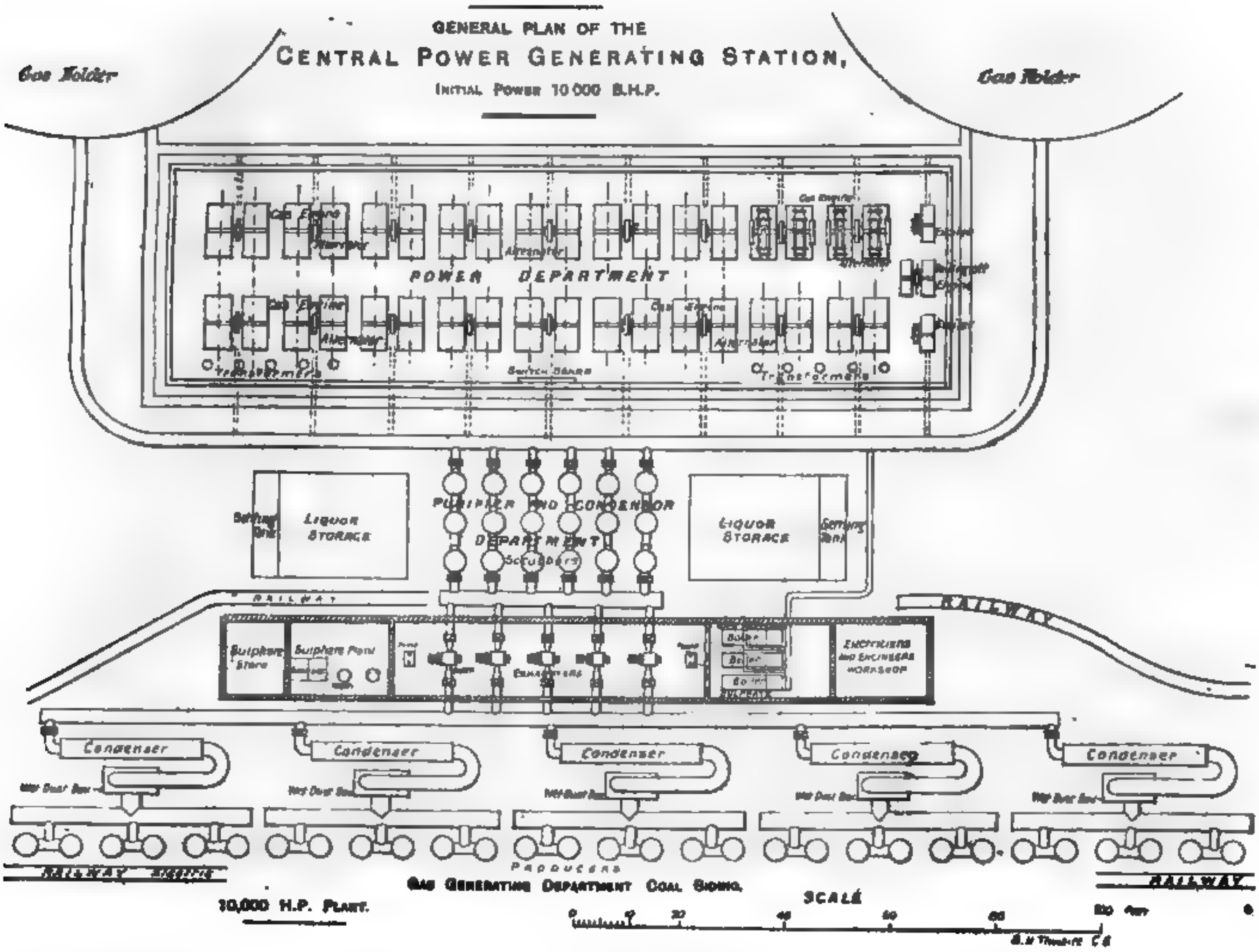


FIG. 1.

let us refer to one example. If there are 10 engines, each of 10 h.p., and each engine is required to work only one hour during a day of 10 hours, under the present system at least 100 h.p. of steam-producing plant would be necessary, whereas with a central power generating station connected with each works it is quite possible, where the working hours are sufficiently distinct to adequately permit of an engine power equal to 20 h.p., to supply the wants of the 10 power consumers. The first consideration is to convert the thermic value potential into dynamic energy, and with as high a degree of efficiency as possible. We know in precise terms the degree of thermic energy possessed by the fuel; we know also that, besides this thermic capital, the fuel contains a nitrogenous constituent which it is our bounden duty to restore to the plant life from which it originally emanated, and this same duty should compel us to return the carbon of the fuel to the plant in an assimilable form as carbon dioxide and the hydrogen as H_2O, or water. Is it possible to define what is the most economic and practically ideal method of converting heat into work with the assemblage of mechanical parts at present available from actual working data? An answer in the affirmative may be given. The inevitable conclusion of everyone who examines the subject without bias will be that the procedure that will give this ideal method to fulfil the highest fuel That the fertilising value from this fuel should be equivalent to the supply per ton of fuel of the equivalent of the nitrogen to that contained in 22lb. to 28lb. or more of ammonia sulphate. At present these conditions cannot be economically obtained from any other form of motor-generating procedure or plant than a gas engine. The procedure of the steam-engine method has an associated loss far greater than the gas engine, and although it is possible to convert the fuel into a gaseous condition and recover the nitrogen, there are losses attending the employment of such a procedure that partly neutralise the gain. It must be obvious to anyone that direct and perfect combustion actually inside the walls of a motor cylinder must be more economic than the combustion more or less imperfect in the flues of a steam boiler, even if effected under the most favourable conditions. Besides the fundamental advantages of the gas plant and gas motor procedure, the instrument itself is more effective in its useful disposal of work represented by the indicated energy. Take the indicated energy of both the gas and the steam motor and compare it with that available for external work; it will be found that the former is very much more efficient. It is well known that with the type of steam engine utilised on our ocean liners and for driving our largest mills, the reduction in expenditure of fuel for a given dynamic output and value is very consider-

able, and the reduction is a striking and eloquent witness in favour of large power steam engines, which are only available for centralised power stations. But for generating power for driving electric generating machines we require still higher efficiencies, and with relatively smaller powers. A motor of 300 h.p. is the largest that should be used for this character of work. The efficiencies of dynamos or electric generating machines are so nearly perfect that there is only questionable advantage in building excessively large types; but the motive power and elements should be such that, if one or two parts go wrong, it will not involve the arrestation of the entire motive power plant. Besides, it should be possible to reduce or increase the power of dynamic energy production in proportion to the demand, and with large steam engines of 1,000 h.p. and upwards this would not be practicable. There is another and important advantage in relatively smaller power gas engines: the pulsations of piston effort could be so arranged that their effect on the supply would be inappreciable. In the arrangement of the plant, Fig. 1, for the projected coalfield generating stations, gas motors of 300 b.h.p. are intended to be used, a pair of these engines being allotted to each alternating current machine, coupled direct, one engine driving the armature in one direction, and the other the field magnets in a contrary direction.

Chronologic Table showing the Genesis and Historic Phases in the Development of Electric Transmission of Dynamic Energy.

Date.

1826. Conception of the idea that when an armature was forcibly removed from a permanent magnet, the force expended in this removal set up a current in wire surrounding the armature. Discoverer, MICHAEL FARADAY.

1865. The direction of the current produced by the severance of an armature from its poles to a wire surrounding the poles, the result being an increased inductive action and increased induced current, the intensity accumulating until the saturation point of the bar of iron forming the magnets is reached. Discoverers, VARLEY and WERNER SIEMENS.

1867. The use of electromagnets excited by the current from a separate electric generator machine in lieu of the steel magnet. Discoverer, WILDE (Manchester).

1873. Accidental discovery of the reversibility of the electric generating machine at the Vienna Exhibition.

NOTE.—It appears the Gramme Company had two dynamos on view and intended for lighting purposes. One of these machines was in motion, the other idle; a workman seeing some electric cables trailing on the ground, and thinking they belonged to the second machine, connected the cables up to the terminals of the machine that was idle. To his surprise the armature of this machine commenced to revolve. Discovery accidental.

1891. The triphasic alternating current system (high pressure) applied by the Maschinen Fabriken Oerlikon for conveying power over 100 h.p. from Lauffen to Frankfort, a distance of some 112 miles, with a loss varying from 30 per cent. This is the most triumphant success hitherto recorded in the transmission of power over long distances. Fuller details are given in the table of power transmission, *vide* appendix.

N.B.—The triphasic alternating system, known as the Drehstrom, consists in the use of three wires, each having its corresponding alternating current; the phases of impulses follow each other.

Our Natural Sources of Power.

In the face of new industrial competitors, who owe their competing origin to the energy of falling water and its electric possibilities of transmission, it is worth while to enquire whether or not we have natural power resources as auxiliaries to our coalfields. The author had reason a short time back to make a careful examination of the hydrographic data available, and from this he has prepared the diagram which shows at a glance the minimum tidal flow of the British ports having a range of possible use. The author entered very carefully into the question of whether it was economically possible to provide Weston-super-Mare, having a high tidal range, with power by means of turbines placed in the impounding walls enclosing water at high tide, the high tide water flowing through turbined shafts to the low tide level; but on examination of the probable cost of retaining walls, turbines, and turbine shafts, he found that it would be less costly to erect a central power generating station on the opposite Welsh coast, and convey the energy by submarine cable laid across the Bristol Channel. The wind power in inaccessible positions removed from fuel areas of supply may, by the employment of modern wind sail mills, be suitable for generating E.M.F.

Methods of Transmitting Power.

The practicable methods of transmitting power may be divided into three: firstly, the hydraulic; secondly, the pneumatic; and thirdly, the electric. For ordinary quick speed work hydraulic transmission of power is not very suitable. Air or pneumatic power transmission is economically applicable for short distance transmission of small power. In the pneumatic system for forwarding light parcels, as adopted at the General Post Office, London, and at Liverpool, pneumatic transmission has its happiest application; but for comparatively heavy work, and distances over two miles, the loss of efficiency is most serious. On the day of the discussion of Mr. Sturgeon's paper, read at Liverpool in 1887, and describing the Birmingham compressed air distributing scheme, the author received a letter from Mr. Charles Brown, stating that the Oerlikon Company had succeeded in transmitting several horse power of energy over a distance of some eight miles with a loss of only 25 per cent. It must have occurred to those who understood the meaning of this information that such an economic result spelt obsolete all [illegible] other rival methods of transmitting power, and [illegible] that of the pneumatic transmission; and further, that such a practical result meant the opening out of a vista to the [illegible] engineers, the growing width and length of which it would be impossible to calculate.

Since this first practicable triumph the Oerlikon Company have laid down a very great number of power transmission installations, but none more famous than that of the Lauffen-Frankfort project, which suddenly and vastly widened the [illegible] of usefulness and effect of this magnificent triumph of man in the control of hidden mysteries of Nature's ways of work for the benefit of humanity. The Lauffen-Frankfort results demonstrated, beyond cavil or contradiction, that for distances of upwards of 100 miles the transmission of power can be accomplished with very little loss of the original potential energy, whilst its rival, the air compression method, has [illegible] practical exigencies, both in the instance of Birmingham and Paris. Whereas the electric transmission of power is a [illegible] in practical every-day rough and ready use in very many instances and in almost every part of the world, and is [illegible] up new centres of industry, and new processes of [illegible] and manufacture, that could not have existed without the transcendent advantages associated with the use of this [illegible] pulsating energy; and no record of man's genius [illegible] on which are set forth the history of the mastery of this [illegible] means of transmitting energy for the purposes of [illegible] embellishing life. The high tension, or pressure, system of transmitting energy has long been the acknowledged exp[illegible] the high efficiency of Faraday's condensation or [illegible] long distance planetary telescopy, and there is little [illegible] when we obtain the right insulation, the voltage, or pressure, of the pressure in electric transmission will be increased to such an extent as to enable a very light wire to carry enormous potentials of energy with very little and even negligible losses [illegible] due to ohmic resistance.

Cost of Energy to the Consumer.

Taking the report of the Birmingham Compressed Air Commission as a basis of computation it appears that the [illegible] of motive power plants did not exceed 20 h.p., and for all [illegible] below this the cost may be taken to vary in the [illegible] between £10 and £18 per annum per horse power. This [illegible] covers the cost and depreciation of the engine and boiler [illegible] repairs and lubrication, rent of land and buildings, [illegible] coal, water, and labour. The cost of this energy delivered [illegible] and including the hiring rates for motor [illegible] should not exceed £4. 10s. to £5 for 3,000 working hours per annum; it is most probable that the figures will be less [illegible] the charge for energy was made to cost the consumer from £7 to £9 per horse power per annum it would be a great gain to him, not to mention the lessened anxiety, and he could also arrange to pay for his power in proportion to the amount used. According to a letter from M. Emil Huber, of the Maschinen Fabriken Oerlikon, the price charged for energy varies from £7. 2s. for powers [illegible] 10 h.p. and not exceeding 200 h.p., but for very small powers [illegible] 10 h.p. as much as £16 per horse power per annum is charged to the consumer.

(To be continued.)

ELECTRIC TRACTION.*

BY FRANCIS G. BAILY, B.A., A.M.I.E.E.

The use of electrical energy as a means of locomotion is of recent development, though the idea and the first app[illegible] date back to the early days of electrical science, the first attempt [illegible] a carriage being in 1839. At that time primary batteries were the only available source of a large supply of electric current, and [illegible] transforming engines were very crude and inefficient, rendering all serious improvements in electric carriages impossible. [illegible] account it was not until 1873, when the reversibility [illegible] dynamo was proved, that the possibility of success in [illegible] traction was realised, and in 1879 a small experimental [illegible] was tried in Germany, with such good results that two years [illegible] a line was laid in Berlin for permanent use, and [illegible] running up to the present day. The first idea of [illegible] was to collect the current from an insulated conductor [illegible] side of the track, the current being generated at some [illegible] the line, but shortly after this time the invention of storage batteries suggested the simpler method of carrying the [illegible] energy about on the vehicle, thus avoiding the necessity [illegible] conductor all along the road, with its obvious [illegible]. The plan was found practicable, and for the last 10 years [illegible] has been a vigorous discussion, which has not yet been decided as to which method is the better.

The difference is a fundamental one. By the use of storage batteries the carriage is independent of any special track [illegible] is complete in itself, so long as the charge is not exhausted. [illegible] battery is replenished during idle hours, or is replaced [illegible]

* Abstract of lecture delivered to the Liverpool Polytechnic Society.

Swindon.—The tenders for one year's lighting of New Swindon by electricity or other means are to be sent in by 12th inst.

Lancashire Asylums.—The Lancashire Asylums Board have granted a sum not exceeding £1,150 for the lighting of Whittingham Asylum with electric light.

Accrington and Church.—The inhabitants of Church, near Accrington, have opened up negotiations with the Co-operative Society to light Church by electricity.

Removal.—Messrs. Gwynne and Co., engineers, have removed from Essex-street, Strand, where they have been established since 1852, to Brook-street Works, Holborn.

Eastern Extension Telegraph Company.—The receipts for November amounted to £49,851, as against £40,686 in the corresponding period, showing an increase of £165.

Western and Brazilian Telegraph Company.—The receipts for the past week, after deducting 17 per cent. payable to the London Platino Brazilian Company, were £3,185.

Paris.—We learn that the Popp Company has just signed a contract with the Compagnie de l'Industrie Electrique for the carrying on and improvement of their electric supply sector.

Penarth.—A discussion before the Local Board on the lighting of Penarth by electricity has been deferred. The sub-committee reported that they had communicated with the towns already lighted.

Bristol Condensers.—We understand that the contract for condensers for the Bristol central station, which was awarded to Woodhouse and Rawson United, Limited, has been thrown up by this company.

La Plata.—The trial of electric tramcars at La Plata was a great success. There was not even a semblance of a hitch. Several railway and tramway managers have been invited to another trial trip.

Bradford Great Northern Hotel.—The lighting of this magnificent hotel, which we described in our issue of November 11th, was carried out by Messrs. Woodhouse and Rawson from their Bradford branch.

Epstein Accumulators.—The Epstein accumulators have been installed for lighting purposes at Messrs. Davis and Timmins and at Messrs. J. H. Ladd and Co., the latter in connection with the Scott-Sisling system.

Commercial Cable.—A quarterly dividend of 1¾ per cent. is announced by the Commercial Cable Company, payable on the 2nd proximo. It has also been decided to redeem £120,000 of the outstanding debenture bonds on the 15th proximo.

Austrian Telephones.—The Austrian Government is understood to be contemplating the purchase of a number of local telephone enterprises throughout the empire, at the estimated cost of £125,000. This money will be borrowed at 4½ per cent.

Rochdale.—At the last meeting of the Rochdale Town Council Councillor Fishwick hoped the Gas Committee would soon seriously consider the electric lighting. Alderman Petrie (chairman of the committee) said they were keeping their eyes on Manchester.

Nottingham.—Mr. Talbot's local knowledge of Nottingham is called in question by a correspondent of a Nottingham paper who does not like the "central site" chosen. A site at Radford or Carrington, with coal some shillings cheaper, would, he thinks, be far better.

Rhyl.—Mr. J. S. Greenhalgh has been protesting against the purchase of the gas works. Buy the winter garden, he says, and use the electric light. He states he shall resign his post on the Council if the vote goes against him, and offers £100 for to start a public subscription.

Art Fittings.—The beautiful electric light fittings which have been viewed with so much pleasure at the opening of the Junior Constitutional Club's new palatial premises in Piccadilly last Friday, were specially designed and manufactured by Mr. Roger Dawson, of 53, Berners-street.

St. Helens.—Alderman Cook (chairman of the St. Helens Gas and Lighting Committee), Aldermen J. C. Gamble and McKechnie, and Councillors Nuttall, Beecham, and Forster have been appointed a sub-committee to consider the question of providing a supply of electricity within the borough.

City and South London Railway Company.—The receipts for the week ending December 4 were £907, against £810 for the corresponding period of last year, or an increase of £97. The total receipts for 1892 show an increase of £1,824 over those for the corresponding period of 1891.

Town Mansions.—Messrs. Pyke and Harris, of New Tothill-street, have just finished the wiring and fitting of the Grafton Galleries, Grafton-street. They are also wiring 47, Gloucester-terrace, Hyde Park; also town mansion for Lord Montague, 9, Queen's-gate, South Kensington.

Teignmouth.—At the meeting of the Teignmouth Local Board last week the Rev. R. D. Maxwell and Messrs. F. Friend and Walton presented a requisition asking the Board to call a public meeting to discuss the questions of the extension of the gas works and the introduction of the electric light.

Windermere.—The Main Roads Committee of the Westmoreland County Council have resolved that it be recommended that leave to put cables under certain main roads for electric lighting purposes be granted Messrs. R. H. Fell and Son, Limited, Windermere, at the rate of 10s. per mile per annum.

Barnard Castle.—The Barnard Castle Local Board are considering a tender from the Brush Company. Mr. Smith, at the last meeting of the Board, gave some figures as to cost, and stated that enough water was escaping from the reservoir to run a 100 h.p. turbine. The matter was carried forward.

Sheffield.—A correspondent of the *Sheffield Daily Telegraph* urges the Corporation to take up the electric light question themselves at once. A committee, he says, not of gas shareholders, should be appointed to enquire into and report upon what is being done in other towns. He would willingly pay twice the present cost of gas.

Liverpool.—The Parks, Gardens, and Improvement Committee of the Liverpool Town Council [illegible] last week to allow the Electric Supply Company to put down their main in Sefton Park in order to supply the houses on the Corporation property where the tenants desired to substitute the electric light for the gas at present in use.

Windsor.—Mr. Evelyn Liardet has made a proposal to the Windsor Corporation to run the electric light installation by [illegible] new motor, and the proposal has been referred to the Water Works Committee. We advise the Corporation to obtain the services of a responsible and experienced consulting engineer, and to follow his advice.

Accrington.—The Accrington Town Council decided on Monday to apply to the Local Government Board for sanction to borrow £10,000 for the erection and equipment of a technical school, and for £10,000 for the purchase of land for the establishment of a central electric lighting station, besides £1,400 for the purchase of baths and washhouses.

Palace of Varieties Searchlight.—A large searchlight has been fixed upon the summit of the new Palace of Varieties, Shaftesbury-avenue, by Mr. Ronald Scott for Sir Augustus Harris. People must be on the look out for its beams sweeping round [illegible] and the light will serve as a beacon leading, we suppose, to the place of a very interesting entertainment.

Edinburgh Tramways.—The Corporation of Edinburgh are prepared to receive offers for a lease of the Edinburgh [illegible] tramways for a period of years to be arranged. [illegible] tenders and a skeleton lease embodying the conditions [illegible] upon by the Corporation will be forwarded to intending [illegible], on application to Wm. Skinner, town clerk, City Chambers, Edinburgh.

Reduction in Telephone Charges.—The National Telephone Company, Western Division, have given notice of a considerable reduction in the fees payable by their subscribers for communication on the trunk lines between the following places: Bournemouth, Boscombe, Christchurch, Southbourne-on-Sea, Poole, Southampton, Basingstoke, Winchester, Fareham, Gosport, and Portsmouth.

Alternating v. Direct.—There is one practical point to be noted in connection with Sir David Salomons's new machine, and [illegible] that once the opposite kind of machine proves practical and efficient, viz., for turning alternating into direct currents, we might very soon see the London Electric Corporation [illegible] courage and possibly having its erstwhile opponents once again on the hip.

Blackpool Conduits.—Tenders are required for excavating for and laying cast-iron pipes, and making good the streets for [illegible] electric light conduits within the borough, for the Corporation. Specifications and forms of tender may be obtained from the borough electrical engineer. Tenders to be delivered to Mr. Howarth, borough electrical engineer, Princess-street, Blackpool, by 14th inst.

Aston.—The success and popularity of the electric installation at the new baths at Aston has induced [illegible] the introduction of electric light throughout the district. The surveyor has been instructed to make enquiries from various places which have adopted electricity, and to embody the result of his investigations in a report for presentation to the [illegible] at an early date.

South London Extension.—The residents in the neighbourhood of The Swan at Stockwell are petitioning against the proposal of the Electric Railway Company to sink a shaft on the [illegible] and through which it is proposed to remove the [illegible] excavating the tunnels. A committee of the Lambeth Vestry proposed to give the company every facility, but in consequence of the objections of the inhabitants the matter has been referred back.

Wolverhampton.—The Electric Lighting Committee of the Wolverhampton Town Council will, we understand, recommend the Council next Monday to accept the tender of the [illegible] Construction Company, Limited, to supply the installation of the electric light within that portion of the borough which the Council have decided to light. The cost of the work will be about [illegible], exclusive of the cost of buildings which will be necessary for the machinery and other plant.

Portsmouth Tenders.—The Urban Sanitary Authority [illegible] tenders for the supply and erection of boilers, steam engines, condensers, steam and water pipes, pumps, overhead travelling traveller, electrical machinery, apparatus, etc. Copies of the plans and specification and form of tender can be obtained of Mr. Alex. Holland, town clerk, Portsmouth, on payment of [illegible] to be returned on receipt of a bona fide tender. Tenders to be delivered by January 5, 1893.

Taunton.—The electric lighting question at Taunton has [illegible] reached an interesting stage. Petitions were got up [illegible] inhabitants that the town, notwithstanding Mr. [illegible], should buy the present installation and carry it on. These petitions have been sent to the Board of Trade, and the result has been that an enquiry is to be instituted into the matter. As

and referred to the Works Committee, said it was not impossible that the lighting of the parish would sooner or later be done by the Dust Disposal Committee. Undoubtedly they would see that the dust of the parish was used to producing electricity whether they liked it or not. When he advocated what might be done with the dust consumed in a dust destructor he was laughed at. Mr. Hodges agreed with this and thought the cost of the electric light could be done away with by burning the refuse of the parish. The proposition of Mr. Brass was carried.

Reading.—At the monthly meeting of the Reading Town Council last week, the surveyor (Mr. A. E. Collins) reported that he had been in communication with the Reading Electric Lighting Company respecting the supply of current for lighting the large town hall. Their manager (Mr. Yeatman) told him at present his company could not supply current, their machinery being already loaded to its fullest capacity. He thought that if the arrangements now in progress for obtaining a provisional order and forming a company to supply electrical energy throughout the town proceeded satisfactorily current could be supplied in from 18 months to two years. The charge would be about 12s. per hour for current. The Town Halls and Markets Sub-Committee were instructed to reconsider and report to the committee on the subject of lighting the large town hall with electric light, or taking measures in some other way for protecting the timbers in the roof of the hall. At a subsequent meeting on November 24 the sub-committee reported that they did not at present recommend that any alteration be made in the lighting, especially in view of the probability of the Reading Electric Supply Company, Limited, being at a comparatively early date in a position to supply electric current to the Corporation for the purpose. The sub-committee, however, recommended that the timbers in the roof of the hall be painted near the gas jets with asbestos paint, and that the surveyor be authorised to provide shields to prevent the gas light blowing out, as now often happens. This report was agreed to.

City Lighting.—At the meeting of the City Commission of Sewers on Tuesday, the subject of the electric lighting of the streets came forward. Colonel Heywood, the engineer, said he had applied to the Gas Light and Coke Company with regard to utilising the existing lampposts in the side streets for incandescent lights in such a way that if the electric light should fail the gas would still be available. The company had replied, pointing out the difficulties under which they at present were carrying on the street lighting. They were being prosecuted by the City authorities for the impurity of the gas supplied to some of the lamps, which impurity was due to the presence of sulphuretted hydrogen owing to the stagnant gas in the disused gas pillars and pipes. Again, lamps were continually being lighted by unauthorised persons in consequence of the failure of the electric light, and by mischievous people passing on omnibuses. The loss arising from these practices was not so serious when the lamps were visited twice a day for the purpose of turning the lights on and off. The company thought the Commission would recognise the fact that they had done all in their power to facilitate the improved lighting of the streets even at considerable cost to themselves, and notwithstanding that the concessions made from time to time were in favour of an opposition mode of lighting. The company could not allow their fittings to remain as suggested, but they proposed, as soon as the lampposts were utilised for the electric light, to vacate them altogether. Colonel Heywood said that was a most important matter for the Commission. There would be no alternative supply in case the electric light should fail. The letter was referred to the Streets Committee.

From the "London Gazette."—The issues of the *Gazette* for November 25 and 29 contain much interesting information as to proposed work. The issue of November 25 has the following:

HARROGATE in its Bill takes powers to empower the Corporation to erect dynamos, engines, and other machinery for the generation and supply of electricity on the lands hereinbefore described and known as the Jenny Plain Farm or Irrigation Farm, and to authorise the Corporation to erect or lay down conductors, electric lines, and other electrical apparatus, for the conveyance or transmission of electricity from the proposed works to the borough, and for those purposes to break up and interfere with streets, highways, drains, gas and water mains and pipes, and in respect of the matters aforesaid, to confer on the Corporation all or some of the powers given to the Corporation by the Harrogate Electric Lighting Order, 1891, and the Electric Lighting Acts, 1882 and 1888.

BECKENHAM desires to obtain a provisional order for electric lighting.

CITY AND SOUTH LONDON RAILWAY ask for additional powers to obtain land for completion of railway and for other purposes.

BRIGHTON AND HOVE ELECTRIC LIGHT COMPANY ask for leave to bring in a Bill and to pass an Act for a variety of purposes connected with the supply of electric energy.

ST. MARY, ISLINGTON (NORTH), for a provisional order for the Holloway Electricity Supply Company.

TAUNTON also requires a provisional order.

COLCHESTER, among other things, asks for a provisional order.

BRIGHTON AND ROTTINGDEAN.—This Bill deals with a unique subject. It proposes to form a company and construct an electric railway from Paston-place groyne to Rottingdean. The following abstract from the *Gazette* notice will explain the views of the promoters. To make and maintain the railway, jetty or landing place, and works hereinafter described, or some part or parts thereof, with all proper stations, platforms, approaches, sidings, buildings, apparatus, generating stations and machinery, appliances, works and conveniences connected therewith, that is to say: 1. A railway commencing in the parish of Brighton, in the county of Sussex, near the Paston-place groyne, on land, beach, or foreshore, leased by

the Corporation of Brighton from the Crown, thence proceeding along the beach and foreshore on the level between high and low water mark, at a distance of about 100 yards from the cliff, to the village of Rottingdean, and terminating at a point on the seashore immediately to the westward of Rottingdean Gap, in the parish of Rottingdean. 2. A jetty, or landing stage, commencing at the termination of the before mentioned railway in the parish of Rottingdean, and proceeding thence in a southerly direction over the foreshore and into the sea for a distance of 200ft., or thereabouts, and terminating in the sea. It is intended that the railway shall be constructed on a gauge of 24ft., and that the carriages to be run thereon shall be moved by electricity or mechanical power, and that the platforms or bodies shall be placed at such an elevation as to be safe from interruption by the sea.

BLACKPOOL, ST. ANNES, AND LYTHAM require an extension of tramways which would probably be worked electrically.

WEST METROPOLITAN TRAMWAYS COMPANY require further powers and, among others, for the use of electric traction.

HAMMERSMITH applies for a provisional order, as does HUTTERSFIELD, and ditto ALTRINCHAM and BOWDON, on behalf of the Manchester Edison Swan Company.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY desire confirmation of an agreement transferring some of the powers of the Chelsea Electricity Supply Company, and other powers.

NEWMARKET.—The British Electric Light Company ask for a provisional order for Newmarket.

SALFORD introduces a Bill to construct tramways which may be worked electrically.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY requires further powers for extensions and alterations.

The *Gazette* of Nov. 29: ISLINGTON.—The County of London Electric Lighting Company ask for a provisional order.

BRIGHTON.—Brighton and Hove Electric Lighting Company. Provisional order to supply within the borough of Brighton and the parish of Preston.

BIRMINGHAM.—Central (Cable) Tramways. Construction of tramways with power, among other things, to use electric traction.

Chelsea.—Mr. T. W. E. Higgens, A.M.I.C.E., the surveyor to the Vestry, has reported upon the proposed Clapham and Paddington Railway. The report deals fully with the whole matter, and the possible disturbance, as well as value to his district. The remarks made in the report dealing with electric traction, if used, are as follows: "It must also be borne in mind that the description of car to be used on this line will differ very considerably from that used on an ordinary railway. The weight of a train on the District Railway when loaded with passengers is said to be about 200 tons, whereas a loaded train on the South London Electrical Railway is said to be only 40 tons. It is quite possible that the trains to be used on the proposed Clapham Junction and Paddington Railway may be less than that, if the motive power is cable power instead of electricity. The clause in the *Gazette* notice dealing with this matter says: 'The motive power to be employed will be cable power or electricity, or such motive power (other than steam locomotives) as the Board of Trade may approve,' but I think it is highly probable that electricity will be used, as the principal engineer to the scheme is Mr. J. H. Greathead, who constructed the City and South London Electrical Railway, which is the pioneer railway of its kind. If the motive power is electricity, and cars of a similar description to those on the City and South London Railway are used, I should think that the passing of an ordinary builder's cart will shake the houses far more than a passing train. As regards the Square gardens, the promoters are clearly asking for an easement, and one which they could not expect to obtain for nothing. It should, however, be said that the passing of trains under the gardens will

in any way interfere with their use by the public, and as the public will eventually be benefited if the railway is made, I would suggest that the Vestry ask the agent to the promoters to confer with them as to the annual rental to be paid by the company for the privilege of passing under these gardens."

Coventry Tramways.—At the last meeting of the Coventry City Council the Mayor (Mr. Singer) moved the adoption of the report of the General Works Committee with reference to the proposed introduction of electric traction on the tramways. The system proposed by Mr W. S. Graff Baker, the owner of the tramways, is that known as the Thomson-Houston overhead-wire system. While admitting that in the matter of efficiency the system left nothing to be desired, the Mayor contended that the overhead wires were very detrimental to the appearance of the streets, and on that ground they ought not to consent to the introduction of the system into the narrow streets of Coventry. A letter was read from Mr Baker commenting, by the way of reply, upon the General Works Committee's report, and stating that the appearance of the wires at Leeds bore no resemblance to the wires and supports as they would be constructed in Coventry. The Mayor said the proper policy was to wait. Alderman Tomson seconded the motion, referring to the very ugly and offensive erections overhead. In wide streets they were bad enough, but in narrow streets they would be still worse Alderman C. J. Hill opposed the report so far as the eighth clause was concerned, which recommended sanction to the temporary use of steam, to which he was opposed most strongly He proposed that the report be referred back to the committee to deal with the point. Alderman Farish seconded the amendment, which was lost by a large majority. Mr. West said he was not at all satisfied with the report. He strongly supported the electric tramways and reminded the Council that only seven months ago the Coventry Corporation cursed steam tramways in the heartiest manner, and asked for electricity; now the General Works Committee objected to electricity and proposed to approve of steam. He moved that the matter be referred to the Council in committee. Mr Lee, in an animated speech, supported the amendment, remarking that the system was giving every satisfaction in Leeds. Alderman Tomson having spoken, Mr Loudon said: If it was to be a question of steam or electricity with overhead wires, then, by heavens, let them have electricity! He contended that the matter had not received fair treatment in the General Works Committee. Alderman Marriott, as chairman of that committee, strongly protested; and Mr. Andrews, in supporting the report, objected to the attempt to force the hands of the Council The question was discussed at great length in an animated and excited manner. Ultimately, the Mayor said the whole question was one of the unsightliness of the overhead wires, and announced that Mr. W. S. Graff Baker was prepared to erect poles and wires along a portion of the route to give the Council an opportunity of judging, and the matter was then adjourned.

Nottingham.—The Special Committee appointed to deal with the electric lighting of the borough have prepared the following report, which was presented to the Town Council at their meeting on Monday: "That the delay which has taken place since their last report was presented to the Council in November of last year has been used by your committee for the purpose of carefully considering what steps the Town Council should take to carry out the electric lighting of the town, and of obtaining information to guide them in the course which should be adopted with respect thereto. Your committee have made themselves acquainted with the method of electric lighting used in various towns in the provinces, and in London and its suburbs. The electrical engineer, Mr. H. Talbot, has been engaged under the direction of your committee in making himself acquainted with the whole of the central portion of the town, with the view of advising as to the best method of supplying it with electricity. Mr. Talbot's report is printed in the appendix. Mr. Talbot recommends the low-pressure continuous-current three-wire system, in combination with the high-pressure continuous-current and transformers. Your committee have had some anxiety with regard to a site for a central station. They advertised in the local papers, and the most suitable site which has been brought under their notice is that mentioned in the report of the engineer—viz., the site between Talbot-street and Wollaton street, known as 'Holborn Villas' This property can be purchased at the price of £3 12s. 6d. per yard They are of opinion that the price is fair and reasonable. They therefore advise the Town Council to authorise them to conclude the purchase of the above site for the purposes of an electrical station The whole of the land will not be required at once, but it is only prudent to make provision for the future extension of the works The Council will see that the total estimated outlay is as follows:

Land in Wollaton-street	£10,175
Capital outlay, buildings, plant, mains, etc.	34,580
Total	£44,755

Your committee strongly recommend that the above purchase should be completed, and that the necessary plans, drawings, and specifications, as set forth in Mr. Talbot's report, should be put in hand for the building and plant required for a central station, and that the consent of the Board of Trade should be obtained, and that your committee be authorised, as soon as such consent is obtained, to advertise for and accept tenders for the execution of the necessary works, and that your committee should be authorised to take all such steps as may be necessary to give effect to their recommendations. Dated this 15th day of November, 1892. John Turner, chairman. The engineer's report is as follows: 'Gentlemen,—I have the honour to report that after mature and careful consideration of the question as to the best means of supplying electrical energy to the town of Nottingham, under the Nottingham Electric Lighting Order, 1890, and having due regard to the probable requirements of the town as to the use of electrical energy both for lighting purposes and for motive power, I beg to advise the adoption of the low-pressure continuous-current three-wire system, as being the most suitable and convenient for meeting the demands of a manufacturing town. But to make this system more economical and able to supply distant and scattered areas, such as the park and the north-east portion of the town, I advise the use of high-pressure continuous currents, with continuous-current transformers and batteries. This latter part of the system could be added when required. With a low-pressure three-wire system an area of one and a half miles diameter can be supplied from one generating station, providing the station is near the centre of the area; but by using transformers the area can be increased to two miles On inspecting the town with a view to the selection of a site suitable for a generating station, I find that the only one available in a central position is that lying between Wollaton-street and Talbot-street, and known as Holborn Villas. This site contains about 2,800 square yards, and is most central. By taking this as a centre and describing a circle of three-quarters of a mile radius (which is the practical limit of a three-wire system) it extends to Hardy-street on the north-west, Emmanuel Church on the north-east, Sneinton Market on the east, Bloomsgrove-street on the west, and Waterway-street on the south. I advise that the buildings at the generating station should be at first designed to contain sufficient plant for supplying electrical energy for 13,000 8-c.p. lamps, but plant should only be put down for 10,000 lamps. This would add but little to the expenditure, and would enable more plant to be put down when required without having to extend the buildings. The buildings to be so designed and constructed that should necessity arise they can be extended at any time without interfering with the working of the station. The chimney should be built of sufficient capacity to be able to accommodate boilers capable of generating steam for supplying at least 20,000 8-c.p. lamps, as the extra cost entailed in building a large chimney would not be so great as building a second one when an extension of the plant becomes imperative. I advise the use of Galloway or Lancashire boilers, with a feed-water heater. This apparatus, by utilising the heat of the exhaust steam, raises the temperature of the feed water to about 200deg. F., and the condensed steam can be used in the boilers, thus saving coal and water, and in addition preserves the boilers to a great extent from incrustation. Willans central valve engines are in use at most of the electric light stations in England, and from my experience I consider them to be economical, and to cost no more for repairs than any other type of high-speed engine. There are some good open type vertical engines made by Davey, Paxman, and Co., of Colchester, and Belliss and Co., of Birmingham. The former are being used at one of the London stations, and the latter have been selected for the central station at Preston, but having had no experience with these particular engines I cannot speak of their efficiency. I advise that the dynamos should be tendered for by the best-known makers, and that in the specification there should be clauses to the effect: 1. The contractor to state the amount of water he will guarantee shall not be exceeded per electrical horse-power at dynamo terminals per hour. 2. The dynamos to be subjected to eight hours' continuous run at full load at the contractor's works in the presence of the Corporation electrical engineer. 3. At the end of the run to pass the Admiralty specification as regards heating, etc. These must be laid in all the streets mentioned in the second schedule of the provisional order, and known as the 'compulsory area,' and in other streets when required, in compliance with the Nottingham electric lighting order. Low-pressure mains are usually of bare copper strip carried on insulators in concrete culverts under the footways. This system has the advantage of being cheaper than any other when large mains are necessary, but for small mains the cost is about the same as for insulated cables. The disadvantages of bare copper mains are: 1. The work takes longer to execute, and, therefore, causes greater inconvenience in busy thoroughfares. 2. Precautions have to be taken to keep the culverts free from water or gas. I advise that bare copper should be used where large mains are required, and that insulated cables drawn through iron pipes, or other approved conduits, should be used where only small distributing mains are necessary; and to ensure a good and efficient system of mains, the contractor should be required to keep the same in a satisfactory condition at his own expense for a period of three years after the completion of the work, and at the expiration of that time the Corporation to take them over only on condition that they pass the test as mentioned in the specification. These should be tendered for by local engineers. I advise that a five-ton traveller should be erected in the engine-room to facilitate the erection and dismantling of machinery. I do not advise the use of more batteries than are absolutely essential for the economical working of the station, and consider that one capable of supplying 1,000 8-c.p. lamps would be sufficient to guard against a sudden breakdown of machinery, and to supply current without running the machines during the hours of small demand. A small battery would be required for the park district should there be a large demand. Whatever type of battery is used should be maintained by the contractor in an efficient state, at a reasonable rate, and for a lengthened period. These should be tendered for by well-known contractors. There are several kinds of meters in use at the present time, but none of them have as yet been certified by the Board of Trade. Probably before a meter is required in Nottingham the Board of Trade will have certified

some. I estimate the capital outlay on buildings of sufficient size to accommodate plant for 13,000 8 c.p. lamps, and generating plant, mains, meters, etc., for 10,000 lamps at £34,580. The site in Wollaton-street contains 2,807 square yards, and at 72s. 6d. per yard will cost £10,175, making a total expenditure of £44,755. The approximate cost of working a central station of 10,000 8-c.p. lamps, including maintenance and depreciation, and assuming that the whole of the lamps will be in use for 600 hours per annum will be £3,509, and the revenue derived from 10,000 8-c.p. lamps, assuming that each lamp is in use for 600 hours per annum, and 6d. per Board of Trade unit is charged, will be £4,950—showing a profit of £1,441, or 4 per cent. interest on the cost of the installation, exclusive of the land. The revenue from the same number of lamps if in use for 700 hours each per annum, will be £5,775, and the approximate cost of working the station for supplying 10,000 lamps for 700 hours per annum will be £3,587, showing a profit of £2,188, or 5½ per cent. interest on the cost of the installation, and a proportionate part of the capital (viz., £3,500) expended on the site. It is found in practice that only three fifths of the lamps installed are ever in use at one time, so that it is perfectly safe to connect 16,000 lamps to the mains of a central station having machinery capable of supplying 10,000 lamps. If 16,000 lamps are so connected and are used for 600 hours per annum, the revenue from same will be £7,920, and the cost of producing the electrical energy, including maintenance and depreciation, will be approximately £3,789, showing a profit of £4,131, or over 10 per cent. interest on the cost of the installation, including a proportionate amount for land. It will be seen from the above statements that the cost of running 10,000 lamps for 700 hours per annum is only £78 more than for running the same number of lamps for 600 hours. This is accounted for by the fact that in both cases the standing charges for depreciation, maintenance, and wages are practically the same, and the extra cost is for coal, water, and stores. It therefore follows that as the number of lamps in use increases the cost of production will decrease. The local authorities which have adopted electric lighting are St. Pancras Vestry, Brighton, Bradford, Glasgow, Dundee, York, Oldham, Hull, Manchester, Bristol, Worcester, Portsmouth, Southport, Burnley, Hanley, Aberdeen, Derby, Whitehaven, and Blackpool Corporations.'" The consideration of this report was postponed to a special meeting.

PROVISIONAL PATENTS, 1892.

NOVEMBER 28.

21693. **An improved electrical meter and recorder.** Pierre Feys and Jean Lorwa, 97, Newgate-street, London.

21696. **Improvements in electric smelting of aluminous and other refractory ores or compounds.** Thomas Leopold Willson, 55, Chancery-lane, London.

21701. **Improvements in the reduction or treatment of refractory metallic compounds by electric smelting.** Thomas Leopold Willson, 55, Chancery-lane, London.

21703. **Electric apparatus for illuminating the sights of firearms in the dark.** Giovanni Garassino di Giovanni, 28 Southampton-buildings, Chancery lane, London

NOVEMBER 29.

21750. **Improvements in means or apparatus for use in typewriting, or typewriting inter-communication with the aid of electricity.** Albert David Neal and Howard French Eaton, 55, Chancery-lane, London. (Complete specification.)

21782. **Improvements in electrical resistance coils.** Siemens Bros. and Co., Limited, and John Nebel, 28, Southampton-buildings, Chancery-lane, London.

21794. **Improvements in the manufacture of electrodes for ozonisers** Emile Andreoli, 18, Somerleyton-road, Brixton, London. (Complete specification.)

21803. **Improvements in electric transformers.** Charles Eugen Lancelot Brown, 46, Lincoln's-inn-fields, London.

21811. **Improvements in multiphase alternating-current meters without separate excitation.** Charles Eugen Lancelot Brown, 46, Lincoln's-inn-fields, London.

21830. **Improvements in apparatus connected with flexible electrical conductors and in electrical connections therefor applicable for use in mines.** Claude William Atkinson and the Electrical Coal-Cutting Contract Corporation, Limited, 1, Queen Victoria-street, London. (Complete specification.)

NOVEMBER 30.

21874. **Improvements in electric light and other pendants.** Harold Lyon Thomson Lyon, 59, Chancery-lane, London.

21906. **An electric alarm of danger from fire or water.** Alex Liedcke and Paul Jacobi, 28, Southampton-buildings, London.

21919. **Improvements in the method of making electrical connections and disposition of circuits carrying induced currents.** Camillo Olivetti, 150, Holland-road, Kensington, London.

21940. **Improvements in or relating to multiple telephones.** Leonard Prosper Moreau and Claude Joseph Augustin Munier, 323, High Holborn, London. (Date applied for under Patents Act, 1883, sec. 103, May 28, 1892, being *date of application* in France.)

DECEMBER 1.

21951. **Improvements in the manufacture of porous earthenware pottery articles for electrolytic purp[illegible]** William Allen, Benthall Pottery, Broseley, Salop.

22001. **Improvement in incandescent electric lamps (4[illegible] filament).** Louis Hendle and Edward Russell Cum[illegible] 95, Finsbury-pavement, London.

22034. **Improvements in and in connection with electri[illegible] meters.** Gustav Binswanger, 11, Furnival-s[illegible] London.

22035. **Improvements in electrical switches and other [illegible]** Gustav Binswanger, 11, Furnival-street, London

22038. **Improvements in and relating to stands for incand[illegible]cent electric lamps** Josef Cathrein, 45, Southamp[illegible] buildings, Chancery-lane, London.

DECEMBER 2.

[illegible]. **Improvements in or in connection with an ele[illegible] motive power system.** Wilfrid L. Spence and Stewart and Co., Limited, London-road Iron W[illegible] Glasgow.

22085. **A varying price electric supply meter.** John Pe[illegible], Brunswick-square, London.

22087. **Electrical variable resistance apparatus.** John Al[illegible]ander Colquhoun, 67, Gibson-street, Hillhead, Glasgow.

DECEMBER 3.

22129. **An improvement in electric switches for curren[illegible] high potential** Charles Joseph Wharton, 38, Pa[illegible]ment street, London.

22131. **An insulating material for covering electric and te[illegible]phone wires, bicycle tires, and carriage [illegible]** Frederick Walter William Goodsall and Hasting [illegible] Wright, 40, Holborn viaduct, London.

22164. **Improvements in or relating to electrical [illegible] high-tension currents** George Hinde N[illegible] Chancery-lane, London.

22187. **Improvements in lightning arresters.** Reginald [illegible] 28, Southampton-buildings, Chancery-lane, [illegible] (The Westinghouse Electric and Manufacturing [illegible], United States.)

SPECIFICATIONS PUBLISHED

[illegible]

10273. **Dynamo-electric machinery.** Desroziers. (Sec[illegible] edition.)

1891.

16041. **An improved coupling for lightning conductors.** Lewis, 3, Great Winchester-street, E.C.

17042. **Dynamo-electric machines.** MacHaffie.

19134. **Electric meters.** Teague.

19972. **Telephone circuits.** Mayer.

19973. **Electric arc lamps.** Maquaire.

19996. **Electric alarum clocks.** Nicholls.

21427. **Water filters and cisterns.** Parker.

21668. **Electric switches.** Marr.

22284. **Suspending electric cables, etc.** Edmunds.

22582. **Electroliers, etc.** Senders.

1892.

372. **Soldering, etc., metal by electricity.** Benardos

475. **Electric testing apparatus.** Swinburne.

499. **Current transformer.** Newton and Hawkins.

10303. **Electrical reciprocating tools.** Carstarphen.

16822. **Electrolytic apparatus.** Craney.

17223. **Welding metals electrically.** Thompson (Coffin.)

17225. **Electrically welding metals.** Thompson. (Coffin.)

17774. **Dynamo-electric machines.** Cowan and Fawcus.

18077. **Electric switches.** Paustf.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	[illegible]
Brush Co.	—	4
— Pref.	—	[illegible]
City of London	—	[illegible]
Electric Construction	10	[illegible]
Gatti's	—	5
House-to-House	5	5
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]
London Electric Supply	5	
Metropolitan Electric Supply	—	6
National Telephone	[illegible]	4
St. James'	—	[illegible]
Swan United	[illegible]	3
Westminster Electric	—	6

NOTES.

Tramcar Brake.—The attempts to use a tramcar brake with spring useful for starting the car, are reported successful.

Royal Institution.—Among the lecturers before the Royal Institution next session are Lord Rayleigh, Prof. Dewar (on "Liquid Air," January 20, 9 p.m.), Mr. Alex. Siemens, and Dr. Ed. Hopkinson.

Military Lamps.—The lamps used under the auspices of the Berlin Electrical Society for military manœuvres at Templehof were of 50 c.p., run by a battery weighing 17½lb. The light lasted some hours, and was sufficient to distinguish persons at the distance of 100 yards.

Tramway v. Telephone.—The important case between the National Telephone Company and Mr. Graff Baker, which is to decide the vexed question of interference between electric trams *v.* telephones, has been partly heard by Mr. Justice Kekewich, and the further hearing is adjourned till January 11.

Secondary Batteries.—Streintz, in his experiments on secondary batteries, is said to have proved by measurements of the E.M.F. the presence of hydrated peroxide of lead as a secondary product on the plates, and considers that its formation is accompanied by a diminution of E.M.F. of the element of charging and its destruction by a corresponding increase on discharging.

The New Westinghouse Lamp.—Already prior claims are made to the peculiar details in use in constructing this lamp. Dr. Böhm, in our contemporary the *Electrical World*, deals with the history of separable incandescent lamps, and says that the feature of the Westinghouse lamp covered by patents must have reference to patents granted to Farmer, Maxim, and to himself. He is also of opinion that the ground-glass stopper "will not hold the vacuum for the required length of time."

Electric Interlocking Signals.—Major Yorke, in his report to the Board of Trade on the Kentish Town accident, says: "Regulations of the most careful and satisfactory nature may be drawn up, but absolute compliance with them cannot at all times be ensured, and I would suggest for the consideration of the company whether it would not be possible to adopt on busy sections of the line some system of electrical interlocking which would prevent a signalman from lowering his starting signal without the permission of the man in the cabin next in advance."

Electric Traction in New York.—Great interest is being excited over the question of electric traction for New York. It is thought that the Philadelphia and Reading Railroad may obtain control of the underground rapid-transit system, and that if this is the case that electric traction would have an opportunity of being tested against steam. Electricity and steam would be run under the same management, and the trouble with the smoke in the tunnels might lead to the establishment of heavy electric locomotives throughout to do the hauling in the tunnels.

Charging Accumulators.—A novel method of charging accumulators on a central station is mentioned by *Industries* as in use at Genoa. A force of 100 h.p. is available during the whole 24 hours, by which two dynamos giving 275 amperes and 115 volts each are driven during the evening. These dynamos in series supply 1,100 16-c.p. lamps. During the day no use is made of the water power, and it has been decided to make use of it for charging accumulators. An installation has been made of 126 Tudor accumulators. As it was not convenient to put in new dynamos, the reserve dynamo used in connection with the other two gives the necessary voltage for charging.

Transmission of Power in Italy.—The industry of electrical transmission of power seems to be making rapid headway in Upper Italy under the influence of the Italian Electrical Society. The great natural resources of the country lend themselves very much to the spread of the industry, and in Milan alone there are 18 installations for electric power, though not of very large amounts. The Alzano waterfall is to be used for distribution, 50 h.p. at three miles, 40 h.p. at half a mile, and 180 h.p. at a quarter of a mile or so. At Pavia power is transmitted from Gravellone 500 yards to the extent of 200 h.p.; while in the province of Navarre the society is laying down a transmission plant of 1,000 h.p. to transmit from Cassagno to Intra, a distance of about six miles.

Telephonic Combination.—The great telephonic competition promised to the metropolis has fallen through, and the National Company has practically won hands down. The result has not been unexpected since the practical agreement of the two concerns; and if the promise to amend its ways and its circuits is carried out, this result may be beneficial. Our controversy with the National has been upon two points—finance and service. The service will have to be made more perfect or troubles will again arise. We shall be interested, perhaps amused, to learn what is the position of the people who have signed on with the New Telephone. Was the printed form of the nature of a contract, or was it provisional and not binding? If it was a contract, does the National take it over?

Electrolysis.—In an abstract from the Chemical Society's *Journal*, Freudenberg is said to have shown a new principle of electrolytic separation of metals. According to Le Blanc, in a solution the amount of the electric charge is identical for one and the same ion, and that, therefore, the point of decomposition of an electrolyte may be exactly determined. As this value differs very considerably for the various metals, the author thought it probable that their separation may be brought about by employing currents of different E.M.F.'s, and the experiments already made show that such is really the case. Thus with a single Leclanché cell, having an E.M.F. of 1·35 volts, silver may be separated from copper and bismuth, and mercury from copper, bismuth, and arsenic. The analysis given show a very close agreement with the theoretical numbers.

Champs Elysees.—One would have thought that electricity would have penetrated the charmed region of the Champs Elysées at Paris long ere this, but it seems not. The central station which is to light the triple boulevards, concert grounds, and the magnificent mansions of this favoured quarter of the gay city is, it is true, now completed. The wiremen are busy in the district, and the light will soon be turned on. The central station is placed on the border of the Seine, and there is some talk of a generating station for an electric railway from the Port Maillot to Suresnes. The same insane hostility which proposed industrial developments of this kind have met with in London, is found also in Paris. There is no real reason, however, to suppose that Paris will not have its cleanly electric railway below as well its cool and brilliant light above the ground.

Waterloo Signals.—The paper of Mr A. W. Szlumper, M.I.C.E., on the signalling at the Waterloo Terminus, which has recently been issued as a selected paper in the Institution of Civil Engineers' *Proceedings*, describes a marvellously ingenious system of signalling. Both mechanical and electrical parts of the apparatus are simply described and amply illustrated. The attempt is to construct a sys-

tem of signals so perfect as to prevent the possibility of accident either by misadventure or intentionally. The apparatus is at once complicated and simple, if that be possible. In place of the ordinary block system the Sykes electric lock and block has been adopted throughout, and specially arranged for terminus working. Visual and audible signals are given. Here the electrical working of the absolute block system is combined with the mechanical working of the outdoor signals, controlled by the movement of trains passing over treadles fixed to the rails, rendering it practically impossible for a wrong signal to be given.

Cold and Ether.—Says a science note in the *Daily Chronicle*: "That extreme cold paralyses every vital function is, of course, a piece of every-day knowledge. But it has been left to Prof. Pictet, who has been conducting some experiments on this subject, to discover that at a temperature of 150deg. below the centigrade zero there is no chemical action between nitric or sulphuric acid and potash, or between oxygen and potassium, though under ordinary circumstances the affinity of the latter metal for oxygen is so great that it will burn if thrown into water, owing to its combination with the oxygen in that fluid. But if the electric spark is played on bodies which have thus lost the power of chemical affinity, some new and curious combinations result. The latest investigation, the conclusions of which, however, have been theoretically presaged for some years past, may require us to reconsider the question of the temperature of outer space, and the possibility of an atmosphere composed of gases in combination existing there."

Patin Alternators and Transformers. — An account is given in *Electricit* for December 8 of the new type Patin alternators and transformers. The improvements in the dynamo relate more particularly to the field magnets, means being taken to form an inner and outer pole, the armature being in the form of a thin drum composed of many flat coils. Their running is very regular under great variations of load, and in one of these machines driven by a turbine furnished with a Picard regulator, the variation of voltage when the load is thrown off suddenly is only 2 per cent. The transformer is in the form of a rectangular box with closed magnetic circuit, the secondary coils being placed next the iron; the magnetic circuit is composed of sheets of iron made up in the form of two wide superposed tubes into which the copper wires pass, the iron discs being U shaped and built up in pairs. The magnetic circuit thus made is very good, and the putting together is easy. The efficiency of the transformer at full load is, it is stated, over 95 per cent., and the absorption empty is very low—"hardly amounting to 2 per cent."

The Wattmeter Method of Testing.—Dr. Sumpner rather astonished the whole meeting, including Dr. Fleming, at the Institution last week by stating, with reference to the wrong wattmeter readings in the celebrated transformer tests, that the explanation was one already given by Dr. Fleming in an investigation some six years ago, in the different behaviour of alternating eddy currents in a metal plate suspended near the coils. From two wrong readings he had been able to calculate seven or eight other wrong readings, which agreed with Dr. Fleming's results. The effect of the lag in the eddy currents was to make the reading greater with a condenser and less with a choking coil. To prove the matter experimentally, he had taken readings with a wattmeter with and without a suspended plate near the coils. The result was with a condenser, true watts 35, with plate near, 146 watts. With a choking coil, the true watts were 105; and with a plate near, 73 watts—showing the rise in one case, and the fall in the other. Dr. Sumpner promised a full working out of his note to the published report in the *Journal* of the Institution.

Automatic Letter Express Delivery.—The Post Office has just placed in front of the Royal Exchange, as an experiment, an automatic box which is intended to be an adjunct to the express delivery of letters and parcels. By dropping a penny in a slot the purchaser obtains an outer envelope, enclosing a small white envelope and one on which the desired communication may be written, resting upon a small desk which falls from the front of the box. At the same time an electric bell calls a messenger from the nearest post office, which is Threadneedle street. If it be desired to forward a parcel by express delivery, the arrival of the messenger must be awaited, but a letter may be deposited in the message receptacle for immediate despatch. The necessary fee has in each case to be enclosed in the envelope bearing the name of the addressee, and should the payment be insufficient, he will be required to pay simply the difference. For this service ordinary postage is not charged, and the fees specified in the case, which are at the rate of 3d. per mile, include the cab or omnibus fares. If the sender requires a cab to be used, the fare must be enclosed in the outer envelope, which has to be marked "By cab." If the convenience thus provided be appreciated at the Royal Exchange, the authorities of the Post Office are prepared to introduce it in many other centres.

Fire Risks.—In continuation of its articles on electric fire risks, the *Review* this week deals with Mr. Heaphy's suggestion of earthing one wire, and disagrees with the proposal entirely. With regard to proper wiring the insurance paper goes on to say: "In our opinion, arguments based on installations such as are made at the exhibitions are fallacious and worthless. They only show the thing at its very best. All the scientific conditions are complied with, and the work is executed in a manner which no doubt does, and is intended, to defy criticism. It is when we come to the ordinary run of work that the trouble begins, and our friend the wireman appears on the scene with his spirits of salts and his unsoldered joints. He is the real master of the situation. We would suggest that, instead of discussing the system, individuals should be looked after. 'The Wireman, and How to Deal with Him,' is a subject which we commend to the electrical experts, more than the merits of different mechanical systems." As long as it is open to any plumber or bellman to open up a branch department and hang out a sign "Electric wiring cheap," we shall continue to have danger from this source; and as long as there are firms who will take installations at any price, there will be a probability of employing bad workmen. The remedy is competent inspection and periodic testing.

Arcas Plating.—The ordinary silver has a slight addition of copper to produce the requisite hardness, and the substitution of other metals in place of copper has been the object of the London Metallurgical Company, whose process of hard silver, or "Arcas" plating, was demonstrated before the Press last Friday. The combination of several metals with silver has been tried with varying success, but by far the best result seems to have been obtained by the use of cadmium. Using a 10 per cent. addition of this metal a brilliant and very hard deposit is formed in electroplating, of a colour indistinguishable from that of pure silver, and with the advantage of taking a high polish, not subject to slight scratching and also of remaining untarnished on exposure to air. The advantages of "Arcas" are great

for most ornamental fittings, and it has been applied to shop fittings, silver plate of all kinds, harness and bicycle parts, and to lamp fittings. Several electrical fitting manufacturers testify to the satisfactory character of the Arcas plating, and we feel sure a very wide field of usefulness is open to the process. The workshops of the company are at 80, Turnmill-street, near Farringdon-street Station, where the plating can be seen in progress. An application of considerable importance in electric light is that of brilliant plated reflecting mirrors whose surface is practically unaffected by the heat or atmosphere.

Niagara.—On Wednesday, at the Society of Arts, Prof. G. Forbes read a paper on the utilisation of Niagara. Of course, as our readers well know, this utilisation is by means of electricity. We can only give Prof. Forbes's excellent paper in brief. The watershed drained through Niagara is about a quarter of a million square miles, so that the flow is practically constant. Suggestions for utilising the immense water power have been many times made, and, in fact, some partial use is made by means of a canal. The introduction of electric transmission, however, changed the course of ideas, and the Cataract Construction Company is working to utilise the hitherto wasted power electrically. Shafts and tunnels have been constructed which will allow the utilisation of about 100,000 h.p. by means of turbines, the turbines being of 5,000 h.p. each. Prof. Forbes stated that while he could speak definitely of the hydraulic work, he could not do the same for the electrical work, which was really under consideration, he having before him 20 distinct plans of the 5,000-h.p. generators which may be used. The remaining portion of the paper was devoted almost exclusively to a rapid review of the good and bad points of the various systems proposed, the tendency seemingly being towards the use of alternate currents and transformers. The author stated that his mind was perfectly open, and he was still able to consider any plan which might be placed before him.

Lighthouse Intensities.—When the Commissioners of Northern Lighthouses made an investigation to determine the luminous intensities of various lighthouses with the view of attaching definite values to them, they found that the intensities hitherto accepted were all too high, and, further, that with revolving apparatus no advantage is gained by increasing the flame beyond certain limits, which seem pretty nearly attained in "four-wick lamps." The policy apparently seems justified by recent results, as it is recorded that "the large burners adopted have been shown by experiments to be not worth the additional expense." Nothing appears to have been said on the value of electric light, and, as is well known, its value has been called in question in time of fog. For a subject of the importance that this must always be to a maritime nation, it seems time that some more settled attitude should be come to upon the whole subject of lighthouse illumination. No doubt the Commissioners have expert information of their own in their possession, but the various hesitations that are apparent, and the disasters which still so often occur consequent on misunderstanding of the penetrating power of light, seem to indicate that the matter might still be settled in a more scientific manner. An exhaustive paper on the subject of lighthouse illumination, dealing with the whole question of high-power light rays in the manner of other investigations that have been undertaken by Cantor lecturers, might prove of lasting utility.

Railway Accidents.—The return just issued by the Board of Trade for the nine months ending at September carries some points within it of importance to the electrical industry. As these may escape consideration unless notice is specially drawn thereto, we would invite the attention of electrical engineers, more particularly those likely to be engaged in traction work, to one matter in the report. It is this, that in the list of accidents which have befallen passengers in connection with railway travelling, 18 passengers were killed and 61 were injured by slipping between the carriages and the platform, including 15 killed and 26 injured while getting into trains. Compared with the number who suffered in railway accidents—12 killed and 476 injured—during the same time, it is clear that there is more real danger to life in getting in and out of the present carriages than there is in making the journey. There is, in fact, a want of proper precaution or means of averting danger at the platforms. We may leave to others the task of urging the necessary reform in carriage doors, footrails, and height of platform of the present railways; but considering the large increase of railway travelling which is likely to ensue by the introduction of electric traction on railways of various kinds during the next few years, we believe it our duty to point out this regrettable loss of life, and to insist that full and proper measures of safety should be taken in all new lines and at all new stations. It should be easy for engineers of electric railways to obviate this annual holocaust of unwary passengers.

A Non-Commutator Dynamo.—Under the title of "A New Method of Field Excitation," Mr. H. L. Tyler (in the New York *Electrical Engineer* for December 7) describes a dynamo of novel design, which he regards as obviating several defects of the present form. For a long time he has been working at a machine to reduce the cost, the complication of parts, and the sparking, and one has been produced embodying the points desired. The dynamo is of the stationary armature type, and the method of exciting the inner revolving field constitutes the novel feature. The exciting current is fed through a pole-changer commutator (the commutator in the ordinary sense being done away with entirely). The "changer" receives an alternating current, and alternately feeds the fields, the four sections of each ring being the terminals of the field coils, and not for the purpose of delivering the current in a continuous direction. The pole-changer delivers the current practically in the same state (alternating) as it is received. The revolving fields are in the shape of a thick cross wound so as to give a N pole at one arm and S pole at the next, so that two similar poles are at opposite ends of the cross. The lines are forced outwards at the N poles and drawn in at S poles, the poles reversing at the quarter-turn, keeping always the same relative polarity. "This method of field excitation," says Mr. Tyler, "at first appeared impracticable, but I have tested it with gratifying results. There is no sparking whatever even on a dead short circuit. The dynamo is made absolutely noiseless by a thin non-magnetic casing encircling the fields. There are any number of ways to place the armature coils, but it appears unnecessary to designate them. The general nature of the machine admits of first-class construction at a surprisingly low cost, and its high efficiency and simplicity are among its best recommendations."

French Submarine Cables.—A description, with illustrations, is being given in *Electricité* (November 10, 24, December 1, 8) of the manufacture of submarine cables at Calais. The Société Générale des Téléphones, whose factory is thus described, purchased the "Westmeath" to lay their cables, rechristening the vessel the "François-Arago." The principal cable laid is that from Marseilles to Oran, of which we have already given some particulars. The total length of this cable is 592·61 nautical miles (1,097·5 kilometres). The total resistance of the core is

6,363 ohms, or 10·74 ohms per mile. The capacity, after two minutes, is 142·3 microfarads; and the insulation resistance is 11,861 megohms per nautical mile. The Telephone Society only makes and lays cables, but will not interfere with the working. This lies with the Société des Télégraphes, whose cables are claimed as twelfth in importance out of 28 private companies. These cables are of small length, but of an importance which increases. They unite the Antilles with South America, an advantageous position. Suppose a message from Rio to New York. By the Brazilian Company it would go from Rio to Pernambuco, thence to Madeira, thence to Lisbon, and from there to London, finally to New York—a total of five transmissions, and a distance of 8,000 miles. With the French cable the message would go to Vizeu, and thence sent direct to New York—three transmissions and 3,000 miles—taking one day only, instead of two or sometimes three. In 1890 the Société des Télégraphes obtained the privilege of landing at Brazil cables from United States or Antilles, and has the overhead lines of Brazil to its own lines, and it is expected that the North American lines will also soon be connected. It will be remembered that, after much diplomacy, the society obtained on June 10 of this year the exclusive concession to land at the Azores. The company therefore expect to connect its lines from the Antilles to Europe by way of the Azores and Lisbon, and this, it is thought, will place the French company on terms of equality, or even of superiority, with the British companies in the Atlantic.

"There is Nothing New."—The interest excited by the experiments conducted by Mr. W. H. Preece with a view to electric communication between distant points without the intervention of wires, has not only drawn from Mr Willoughby S Smith an account of his father's experiments in the same line and of his own successful establishment of such communication between the shore and the Needles lighthouse in June last, but it has caused the people of Dundee to discover that both Mr. Smith and Mr. Preece have been in a way forestalled by one of their deceased townsmen, who experimented so far back as 30 or 40 years ago with success. This was Mr. James Bowman Lindsay, a man apparently of deep learning and considerable scientific attainments, but whose labours and accomplishments, curiously enough, have been allowed to fall completely out of general ken. Dr. Alexander Keiller, a pupil of Lindsay's, read a short account of his scientific experiments before the British Association in August last, and now another of his old pupils, Dr. Alex. Paterson, Bridge-of-Allan, comes forward to say that he can vouch that the so-called discovery that messages can be transmitted from island to island, or from ship to mainland, without wires is not new, for he well remembers that 60 years ago "the late learned scientist, James Lindsay, of Dundee, showed that he could transmit a message across the River Tay without wires." Lindsay's experiments and successes in this direction were well known at the time, but they seem to have been insufficiently recorded. In a biographical account of him, published at the time of his death, in the *Dundee Advertiser* of 30th June, 1862, it is distinctly claimed for him that he had discovered "the principles of the present system of electric telegraphy" by his own efforts, as early as, if not earlier than, Morse or Wheatstone. As a philologist, Mr. Lindsay was certainly entitled to high rank, as some of his published works show. There is no adequate biography of this remarkable Dundonian in existence, but as there are still a few survivors, such as Dr. Paterson, who were privileged to know him, the hope is expressed that some effort will be made to preserve the name of so accomplished a scientist from neglect by means of a worthy biography. It will be a gratifying circumstance for Dundee people, and a curious coincidence as well, should they be able to show that the discoverer of telegraphy and the inventor of the adhesive postage stamp were both respected burgesses of Dundee.

Large Gas Engines.—We are by no means certain that the position of the gas engine in the electrical industry has yet been correctly gauged. The advantages it presents for central station work are numerous. The necessity of keeping the load factor high forces the use of small units of power. These must be capable of being started at a few moments' notice, must occupy little space, and be cheap in working. Now, the gas engine has just these advantages, and the additional advantage of doing away with the boiler. The only objection is that the units hitherto have been too small—though makers are ready to supply large engines, their use is not sufficiently general to justify the adoption of 100 h.p. engines in central station work. The cost of fuel also is somewhat high, purified gas coming to much the same price for large engines as coal with boilers. Still, large gas engines are coming into use, and this fact will soon induce the station engineer to instal them for central supply. At Camden, New Jersey, a gas engine rated at 100 h.p. is in use, operated by a mixture of air and gasoline vapour. This provides a fuel not only invariable in quality but quite inexpensive. In quantities, gasoline costs 3d. a gallon; and as this engine is run by one gallon of 74-deg. gravity gasoline per horse-power for 10 hours, it will be seen that the cost of fuel (0·3d. per horse-power hour) is not great. The engine at present is only yielding 62 h.p. The cylinder is 16½in. diameter; stroke, 24in., speed, 150 revolutions per minute. The gasoline is drawn direct from a tank considerably lower than the engine, and its vapour is mingled with air without any special carburetting device. The governor limits the number of charges by an air gate passing over one of a pair of tubes. The air gate has two ports, and allows air to be drawn through either tube according to action of the governor. In one tube is a nozzle leading upward from a reservoir containing less than a pint of gasoline, and when the port is open above this tube the engine takes an explosive charge, which is ignited by incandescent tube. As the engine requires no fireman or skilled engineer, and uses cheap fuel which leaves no residue, it has great advantages over the steam engine. The credit of the invention of this engine (an illustration of which appears in the *Electrical World* of December 3) is due to Mr. Jas. A. Charter, who is well known in gas engine circles. We fancy the case should interest British engineers as an instance of the use of large gas engines. The engine was made by Caldwells, of Chicago, and is employed for driving a grain elevator. It is a compact machine, and its use for electric lighting seems likely to spread. With reference to this question of gas engine use, an outlet for ingenuity is also suggested by a recent article in the *Belfast Evening Telegraph* upon the discovery, by a Mr. Harris, of an easy way of making gas. This gentleman, again an American inventor, has a machine in which 10lb. of coal produces 700 cubic feet of gas, and by the addition of a couple of gallons of crude mineral oil this is raised to 100 cubic feet. Mr. Gallagher of Belfast, who introduces the method into the British Isles, vouches for the running of 110 16-c.p. lamps by means of a gas engine for 9d. for 10 hours, and the cost of the gas is given at 2½d. per 1,000 cubic feet. The paper to be read by Mr. Dowson before the Civil Engineers may also serve to turn attention further in the direction of the use of large gas engines.

THE RELATIVE MERITS OF HIGH AND LOW TENSION ELECTRIC DISTRIBUTION.*

BY WILLIAM BUCHANAN, B.SC., A.R.C.S., WHIT.SCH.

When a corporation or company find that they must keep pace with modern progress, and resolve on having an electricity-generating plant, the usual question which first confronts them is: Shall we adopt the high or low tension system? The object and scope of this communication is merely to induce a discussion of this question among the members. The use of high-tension direct current is very limited, owing to the necessary losses—mechanical and electrical—in the combined motor and dynamo-transformer. The only advantages which this system possesses over the alternating-current method are the readiness with which the energy can be stored, and the simplicity of its application to motors for power conversion. The question is thus practically reduced to the relative merits of high-tension alternating-current and low-tension direct-current methods, the latter including the three-wire and five-wire systems.

The chief merits of the high-tension alternating method of distributing electric energy are:

(a) The ease and efficiency of transforming the pressure either up or down. Transformers are now made and used which give out 97 per cent. of the energy supplied at full load, and 95 per cent. at half load, while the loss in running with open secondary is as low as 1½ per cent. of maximum load.

(b) The generating station can be placed in any suitable situation; for example, in proximity to a coal pit or depôt near a good water supply, or where ground is cheap and labour plentiful.

(c) The generating machines may either be worked at a high voltage or at a moderate voltage, the pressure being increased by means of step-up transformers; also the current can be sent along the trunk mains with a small percentage of loss, and without undue losses by heating.

(d) A considerable saving in the prime cost of all the mains.

(e) The advantages of running a large number of arc lamps coupled in series from the moderate-tension leads.

There might also be added as another merit of the high-tension alternating method its application to alternating motors; the advantage of this method for this purpose is obvious, and it has not received the amount of attention which it deserves. In engineering shops the throwing off of one large machine allows the driving engine to race, frequently causing a breakage of tools in those machines which are at work; in spinning factories also, the stopping of one frame often causes the breaking of the yarns on those frames which are running. It is almost impossible with any kind of mechanical governing to entirely check this racing of the engines. In cases like these there seems to be a large field for the use of alternating motors, since the motor must keep perfectly in synchronism with the machine generating the current. If the generator were supplying energy to a number of factories it would not feel the variation in load due to machines being turned off or on, so that it would run at a practically uniform speed, and therefore each motor would do the same.

The disadvantage connected with the use of ordinary alternating motors being that they are not self-starting. They must first be run up to the proper speed, and then switched into circuit at the proper moment. This is, however, overcome in the multiphase motor, with rotary field, designed by N. Tesla.

It is hardly necessary to point out the merits of the direct-current systems, not the least being the readiness with which dynamos may be coupled in parallel with each other, it being only necessary to run up a machine to the same voltage as those already running and then to switch it in. On the other hand, to put two alternators in parallel, besides getting the voltages to correspond, the dynamos must be got to nearly the same speed, if they have the same number of poles in the field magnets, and then switched in when the currents correspond in phase. Although this operation does not require any great skill, still it wants a certain amount of care, otherwise a large instantaneous current may be produced which will probably damage the machines.

At the present time the most important application of electric energy is the lighting of large towns and cities; for this purpose the great advantage of high-tension methods is in the relative sizes of the distributing mains compared to the low-tension systems. This advantage seems much more likely to increase than to diminish, seeing that the supply of high-conductivity copper is limited, while improved methods of insulating are being continually discovered. The simplicity of working is also much in favour of the alternating, compared with combinations of the two, three, and five-wire systems. In towns where there are already a large number of pipes—water, gas, hydraulic, drainage, etc.—the expense and difficulties of laying large culverts are very considerable. The usual method of distributing high-tension alternating current is by means of concentric cables. These consist essentially of an inner conductor or core of stranded copper surrounded by a certain amount—depending on the material used and the pressure worked at—of insulating material; over this is a layer of copper wire forming the outer conductor. The cable is protected by a further layer of insulation, over which is forced a covering of lead, so as to make the cable impervious to moisture. The whole is protected against mechanical faults by a sheathing of steel wires, which are wound above a covering of jute, so as to avoid injuring the lead. It is found, however, that the wire sheathing is not sufficient protection against blows from a sharp pick, nor does it offer much resistance to the sharp wedges driven by sledge-hammers to break up the concrete pavements. The best mechanical protection seems to be got by encasing the cables in cast-iron pipes, the pipes being first laid down and lead-jointed, and then the cable is drawn through in lengths of about 200 yards.

There are a large number of methods in use for joining lengths of concentric mains, or connecting service leads, the most common, perhaps, being to connect the inner conductor by splicing and soldering, then to wind over it a sufficient thickness of insulating tape; over this is laid a number of strips of sheet copper, to which are attached the outer conducting wires by thin copper binding wire; more tape wound over this completes the joint. In lead-covered cables these joints are protected by soldering a lead covering over them; in others, by surrounding the joints by cast-iron boxes charged with oil or insulating compound. Whenever possible, these joints should be placed inside street boxes so as to be readily accessible in case of faults occurring, or when it is required to recharge the boxes with oil or compound, it being found that the oil tends to leak from the box along the insulation of the cable.

The methods of laying low-tension mains are so well known that it will be sufficient merely to mention those of two large companies—namely, "The Westminster" and "The Kensington and Knightsbridge."

The Westminster mostly adopts the plan of fixing the conductors on insulators laid in concrete conduits, then cementing on a concrete cover. The chief merit of this system is that the culvert prevents moisture penetrating to the insulators, and also forms a mechanical protection for the conductors. On the other hand, it has the disadvantage of taking up a wide strip of ground, and breaking up in order to put in joints or examine for faults is rather costly.

The method of the Knightsbridge Company is to stretch bare conductors over porcelain insulators about 50 yards apart, the whole being placed in an open culvert. This method has the advantage of being fairly cheap, and also that the mains are readily accessible for jointing or repairing; its disadvantages lie in the large amount of ground area used, leakage through moist insulators, and corrosion of the copper by acids arising from foul air in the conduits.

One disadvantage which seems to be inherent in the use of concentric distributing mains is the difficulty of locating a fault on a branch circuit, that difficulty being in the fact that a current flowing uniformly along a con-

* Paper read before the Physical Society of Glasgow University, December 16, 1892.

ductor of circular section has the same effect on external bodies as it would have if concentrated along the axis of the conductor.

With the low-tension system it is found to be rather difficult to keep the voltage anything like uniform over a circuit, the fall of potential being different at different places, and often at different times; this necessitates the employment of feeders from the station, and of pilot wires to enable the voltage at distant places to be known.

With the method mostly in use in high-tension distribution, the current is transformed at a number of stations to 2,000 or 2,500 volts, and distributed at this tension to consumers' premises, where it is transformed to 100 volts. There is practically no fall of potential in distributing over a distance of two or three miles at 2,500 volts, and even the small amount there is may be neutralised by cutting out one or two turns of the primary circuit on the transformer. It must also be kept in mind that the fall of potential in an alternating circuit cannot be expressed by so simple a formula as that used for direct currents, but by one which takes into account the capacity of the concentric main, the amount of induction in the circuit, the pulsation period of the current, and the transforming ratio of the converters, as well as the current and ohmic resistance. If the alternations are of high frequency, and the conductor has a capacity large in comparison with its ohmic resistance, the pressure may be even greater at the far end of a circuit than at the generating end.

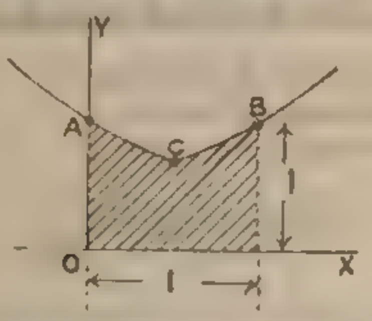
It is shown in Dr. Fleming's book on "The Alternate Current Transformer," vol. ii., p. 170, that if L, R, and V_1 are the inductance, resistance, and potential respectively at the generating end of a circuit — such as a trunk main of concentric cable — and l, r, and V_2 the like quantities for the distributing end, when p is the pulsation of the current, and C the capacity of the cable, that

$$\frac{V_1}{V_2} = \sqrt{\left\{(1 - CLp^2)^2 + C^2R^2p^2 + \frac{(1 - 2CLp^2)(R^2 + p^2L^2) + 2Llp^2 + 2Rr}{r^2 + p^2l^2}\right\}}$$

If circuit beyond condenser is open, then $r^2 + p^2l^2 = \infty$, and the above equation reduces to

$$\frac{V_1}{V_2} = \sqrt{\{(1 - CLp^2)^2 + C^2R^2p^2\}}.$$

The effect due to the capacity of the condenser is very well shown by considering the particular case in which $R = Lp$. Writing Y instead of $\frac{V_1}{V_2}$, and x for CLp^2, the above equation reduces to the hyperbola $Y^2 = (1 - x)^2 + x^2$. Y is $= 1$ when $x = 0$ or $x = 1$, and Y is a minimum when $x = \frac{1}{2}$.



This shows that in the particular case chosen V_1 is equal to V_2 when CLp^2 is equal to zero or unity, while for any value between zero and unity V_2 is greater than V_1, and for values of CLp^2 greater than unity V_1 is greater than V_2.

To enable us to arrive at some definite results, I have worked out approximate values for the lighting of an area of one square mile, by what seems the most suitable distribution in each case, for the high-tension and the low-tension systems.

The method of high-tension distribution adopted is that of using a number of sub-transformer stations from which the low-tension mains are fed at a number of points. The chief loss in the transformer system being due to the running at light load during the day and early morning, it becomes almost a necessity to use some means of minimising this loss. A number of methods of doing this have been tried or suggested. Mr. Ferranti has designed an automatic switch, which cuts out a transformer when the current through the secondary falls below a certain amount. In the sub-station method, a number of transformers being connected in parallel, we may have some cut out and keep those remaining working nearly at full load, and therefore at a high efficiency.

In the case we have chosen as an illustration, it is supposed that the square mile is divided into squares of 220 yards frontage, and that the density of lighting is uniform at the rate of 500 8-candle, or 30-watt, lamps per square. The total number of lights is thus 32,000, while the power required is 960 kilowatts. We will further suppose that the annual load factor is 30, load factor being defined as the percentage which the total work done in a certain time is of what it would be if the load was continuously at its highest value during that time. In the curves of Figs. 1

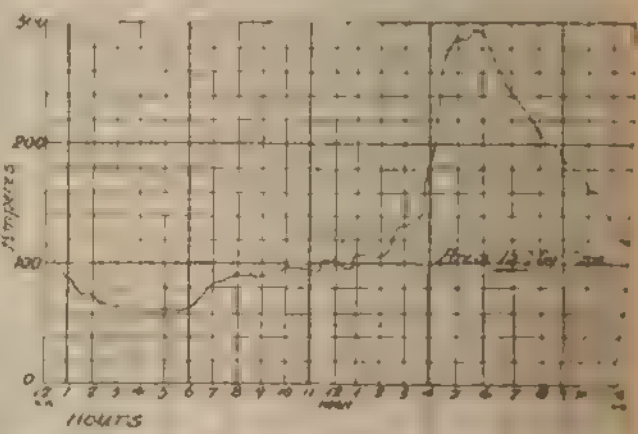


Fig. 1.—Load Curve for 24 hours. Load factor = 42 per cent.

and 2 the daily load factor is the percentage which the area enclosed between the curve and the zero line is of the area got by taking the product of the length of the base line and the maximum ordinate of the curve.

In the high-tension method we will suppose the current to be generated at 8,000 volts at a distance of four miles from the centre of the area to be lit, and transformed to 2,000 volts in the distributing station, being finally reduced to 100 volts at the sub-stations. The dimensions of the cables and mains are calculated by means of Lord Kelvin's

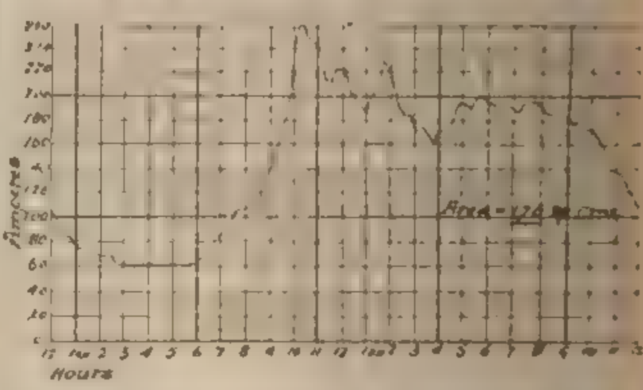


Fig. 2.—Load Curve for 24 hours. Load factor = 57 per cent.

rule: The number of watts lost per annum multiplied by the cost of generating one watt equals the interest on the cost of the mains. It seems, however, that this rule ought to be slightly modified to take account of the fact that the cost of upkeep of a given main will be more than that of a better or more costly one. Thus, a high-tension main requires more insulation relatively than a similar low-tension one, and is thus more costly, so that a high current density would be given by using the rule, but the heating effect of the current causes deterioration of the insulating material with correspondingly increased cost of upkeep, so that it very probably would be found more efficient to use a lower current density by laying a slightly larger main.

A method of arriving at the dimensions of the cables is as follows:

Let p = cost per mile of cable
,, q = cost per mile for laying.
,, A = cross-sectional area of conductor in inches.
,, C = current in amperes.
,, R = resistance per mile in ohms.

Then $(FC)^2 R \times 24 \times 365$ is the watt-hours lost per annum, where F is the annual load factor and C the maximum current which the cable is supposed to carry. Also $RA = 0{\cdot}044$ for ordinary copper, and $p = £\,(3{,}000\,A + 300)$, from practice, for concentric cables. Allowing $7\frac{1}{2}$ per cent. as the interest on cost of mains, then $£\,(225\,A + 22{\cdot}5)$ is interest on cost per mile; but with F = 30 per cent., and taking cost of generating one B.T.U. as 3d., we have

$$C^2 = \frac{20 \times 4{,}000 \times 100 \times 22{\cdot}5\,(10\,A^2 + A)}{9 \times 0{\cdot}044 \times 24 \times 365}$$

or, $$C = 228\,\sqrt{(10\,A^2 + A)}.$$

For $A = 1''$ we get $C = 228\,\sqrt{11} = 752$ amperes per square inch
" $A = \frac{1}{2}''$ " $C = 395$ $= 790$ " "
" $A = \frac{1}{4}''$ " $C = 213$ $= 852$ " "
" $A = \frac{1}{10}''$ " $C = 102$ $= 1{,}020$ " "

But we cannot allow a current density of more than 1,000 amperes per square inch for alternating current, so

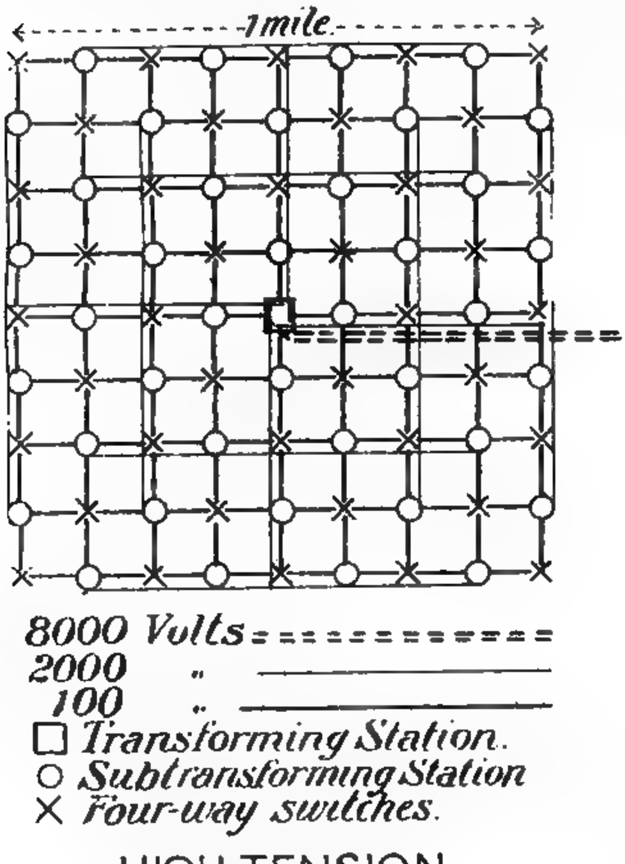


Fig. 3.

for sizes below $\frac{1}{8}$in. section we must calculate the size of conductor by allowing this amount. This apparent defect in the rule arises from the fact that it costs almost as much to lay a small cable as a large one.

The dimensions of the low-tension mains may be calculated by allowing a maximum current density of 1,000 amperes per square inch for the two outside wires, and making the intermediate wires in the three and five wire systems half the sectional area of these.

I have not taken into account the frequency of alternation in calculating the size of conductors, as those for concentric mains are usually made of a number of separate wires, so that if the frequency is about 80 per second the increase of resistance is not large.

The method of dividing up the area to be lit is purely arbitrary, and must be considered quite hypothetical, but still as a means of comparison it will be sufficiently simple and useful. The area chosen and the density of distribution are rather favourable for a low-tension system. It will be observed, from the diagram of Fig. 3, that any fault occurring on the high-tension system affects only a straight length of 220 yards, and by means of a wire laid along the street from end to end, the position of the fault could readily and accurately be found by a loop test. If a transformer failed, the area could be lit from the others by means of the street switches shown in the diagram.

I will now give some details relating to the mains. First considering the high-tension system, we require at least two trunk mains, each capable of carrying all the current. Allowing a gross efficiency of 80 per cent., the trunk mains must be designed to carry $(960{,}000 \div 8{,}000) \div 0{\cdot}8 = 150$ amperes; so we may allow $\frac{1}{4}$ square inch section. The cost of concentric cable $\frac{1}{4}$in. section is about £800 per mile. The two mains can be laid at a cost of about £400 per mile run. Thus the total cost of trunk mains is £8,000. The resistance of this section for alternating currents is $\frac{1}{5}$ ohm per mile, and therefore the total resistance with the two mains in parallel is $\frac{4}{5}$ ohm.

As it may often be necessary to use only one trunk main, it will be more correct to use a load factor of 40 per cent. in this case. If then C_A is the average current strength, and C_m the maximum current, $C_A = \frac{4}{10}\,C_m$, and therefore $(C_A)^2 = \frac{4}{25}\,(C_m)^2$, so that the average rate of loss is $\frac{4}{25}\,(C_m)^2\,R$, where R is the total resistance of the circuit considered. For the trunk mains the loss is therefore at the rate of 2,880 watts, or, taking the cost of generating as 3d. per B.T.U., the loss is £316 per annum. With one

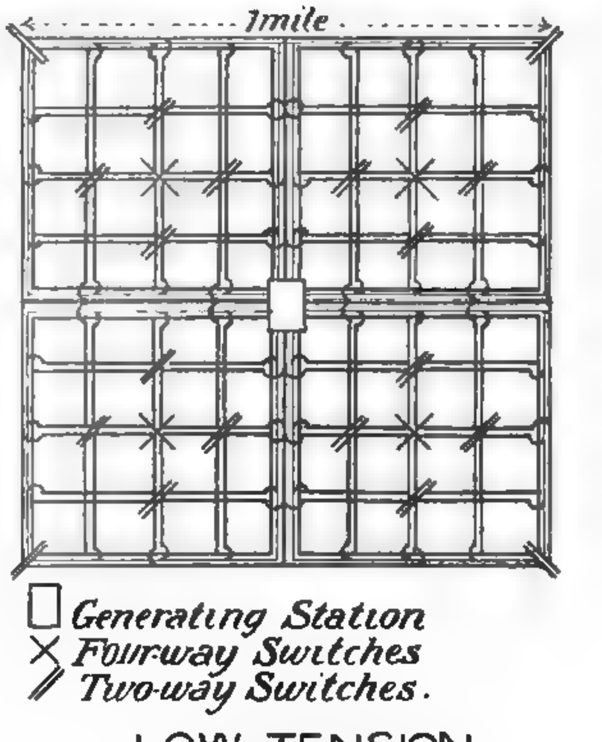


Fig. 4.

main in circuit only, the fall in potential due to ohmic resistance at full load is $150 \times 0{\cdot}8 = 120$ volts or $1\frac{1}{2}$ per cent. at 8,000 volts. With both mains in circuit the capacity effect will most probably annul the drop due to ohmic resistance. The following table gives the sizes of mains required in the various sections, with their cost and the loss in watts.

Details of Distributing Mains.—High-Tension System.

—	Length Miles.	Maximum current. Amperes.	Gauge B.W.	Resistance per mile. Ohms.	Cost per mile. £.	Total cost. £.	C^2R. Average
2,000 volts.	[illegible]	$7\frac{1}{2}$	7/19	5·0	80	160	102
	3	15	7/16	2·0	120	360	243
	$1\frac{1}{2}$	30	7/14	1·3	160	240	322
	$\frac{1}{2}$	45	19/16	0·72	270	135	137
	$\frac{1}{2}$	105	37/15	0·3	620	[illegible]	298
	$\frac{1}{2}$	120	37/15	0·3	620	310	339
100 volts.	4	$37\frac{1}{2}$	19/17	1·0	210	[illegible]	506
	14	75	19/14	0 46	400	5,600	2,260
			Totals..........			7,955	4,257

It must be observed that the lengths given are for

concentric cable, so that in calculating the resistance twice the length must be taken, also in the low-tension leads, since the density of lighting is supposed to be uniform, the actual average resistance is only one half the total resistance of any circuit. The losses tabulated under $C^2 R$ are reckoned on the assumption of an annual load factor of 30 per cent. The cost of laying the mains may be taken as £200 per mile for the low-tension leads, and £300 per mile where both high-tension and low tension leads are laid. We thus have eight miles at £300 per mile, and 10 miles at £200 per mile, or a total of £4,400.

The total cost of the distributing mains is therefore £12,355; the loss due to heating being at the rate of 4,257 watts, and amounts to £480 per annum. Also £480 is 4 per cent. of £12,355; but £480 is 6 per cent. of £7,955—*i.e.*, of the cost of the mains. The following table gives the probable costs of the different parts of the whole system.

Cost of Alternate-Current Plant.

Engines, 5 × 500 h.p. at £4 per h.p. ...	£10,000	
1 × 300 h.p. at £5 „	1,500	
Dynamos, 5 × 500 h.p. at £5 „	12,500	
1 × 300 h.p. at £6 „	1,800	
Boilers, 10 × £500 ...	5,000	
Exciters, 6 × 20 h.p. at £10 per h.p. ...	1,200	
Condensers, feed pumps, and connections	4,000	
Switchboards and instruments ...	800	
Cranes, fittings, pilot transformers, and stores ...	2,500	
Generating buildings ...	4,000	
Land ...	1,000	
Cost of generating station complete		£44,300
Trunk mains ...		8,000
Secondary station:		
Transformers, 20 × 100 h.p. at £2 per h.p. ...	4,000	
Switching gear and instruments	1,000	
Building and land ...	2,000	
		7,000
Distribution:		
Switches, joint-boxes, and fuses	1,000	
Secondary mains...	12,400	
Transformers, 24, $^{20}/_{1}$ for 1,000 lights at £100 each ...	2,400	
16, $^{20}/_{1}$ for 500 lights at £60 each.	960	
Houses, 40 at £10 each ...	400	
Switches, cut-outs, and fuses ...	540	
		17,700
		£77,000

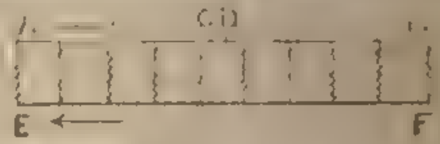
Allowing £3,000 for plans and supervision, the total cost will be about £80,000.

Considering next the low-tension system of distribution, a reference to the diagrams, Figs. 3 and 4, will show that there are two miles of five-wire, four miles of three wire, and 12 miles of two-wire leads. Remembering that five wires are equivalent to 3½ of the outer conductors, and three wires to 2½ the outer, we form the following:

Details of Distributing Mains.—Low-Tension System.

—	Length Miles.	Maximum current Amperes.	Gauge B.W.	Resistance per mile Ohms.	Cost per mile £	Total cost £	$C^2 R$ Average
2 wire	12	75	19/15	0.57	220	2,610	1,151
	12	150	37/17	0.3	410	[illegible]	4,220
3 wire	2½	18¾	19/20	2.3	80	200	54
	2½	112½	37/16	0.37	330	825	338
	2½	[illegible]	37/13	0.18	650	1,625	1,300
	2½	300	37/12	0.14	820	2,050	2,120
5 wire	1¾	318¾	37/[illegible]	0.14	[illegible]	[illegible]	1,[illegible]
	1¾	[illegible]	61/13	0.11	1,[illegible]	[illegible]	1,[illegible]
	1¾	[illegible]	61/[illegible]	0.[illegible]	1,[illegible]	2,[illegible]	2,[illegible]
	1¾	600	61/13	0.068	1,500	2,[illegible]	2,[illegible]
			Totals ...			20,210	15,964

To calculate the loss by heating in a circuit of uniform section, in which the current varies uniformly from zero to its maximum value C, let A B = l be one conductor and E F the return; also let r be the resistance per unit length let C_x denote the value of the current at C, and let C D = dx. We have, therefore, $C_x = \frac{l - x}{l} C$, and heating is at the rate of $\int_0^l C_x^2 r\, dx = C^2 r \int_0^l \frac{(l-x)^2}{l^2} dx$ $= \frac{1}{3} r l C^2 = \frac{1}{3} R C^2$, where R is total resistance of one lead. The loss in the general case in which C_1 and C_2 are the currents at A and B respectively is $\frac{1}{3} R (C_1^2 + 2 C_1 C_2 + \ldots$



The cost of laying will be about £350 per mile for double leads, £400 for three-wire system, and £500 for five-wire system. The cost is, therefore, 12 × 350 = £4,200 for double leads, 4 × 400 = £1,600 for three-wire leads, and 2 × 500 = £1,000 for the five-wire leads, or a total of £6,800.

The total cost of the distributing mains is thus £27,010. The loss by heating is at the rate of 15,964 watts, or at 3d. per unit is £1,760 per annum. Also £1,760 is 6½ per cent. of £27,010.

This is a higher percentage than allowed in the high-tension system, the reasons being that more heating is permissible with low-tension than with concentric high-tension leads, as the risk of damaging the insulation is greater in the latter case; it is also expedient to reduce the first cost of the low-tension mains as much as possible, in order to compete successfully with high-tension systems.

Cost of Direct Current Plant.

Engines, 8 × 350 h.p. at £5 per h.p. ...	£14,000	
Dynamos, 8 × 350 h.p. at £6 per h.p. (including exciters)	16,800	
Boilers, 10 × £500 ...	5,000	
Condensers, feed pumps, and connections	4,000	
Switchboards and instruments	2,000	
Cranes, stores, and fittings ...	3,000	
		£44,800
Buildings, including battery-house	7,000	
Land in centre of area ...	5,000	
		12,000
Batteries, able to give one third the maximum power, 600 cells at £6 each ..	3,600	
Connections and fittings ...	400	
		4,000
Distribution, cost of all mains	20,210	
„ laying ditto .	6,800	
Street switches, joints, etc.	800	
		27,810
Total		[illegible]

Briefly comparing the relative efficiencies of the two systems, we have—

(*a*) *Alternating System.*—Mechanical loss in 500 h.p. engines, 10 per cent.; mechanical loss in dynamos, 2 per cent., electrical losses in dynamos, 4 per cent., loss in trunk mains, 1½ per cent.; loss in station transformers, 3 per cent. (these will always be working full power), loss in 2,000 volt mains, 1 per cent.; loss in sub-station transformers, 8 per cent., and loss in 100 volt mains, 1½ per cent., or a total loss of 30 per cent.—the average efficiency of the system being thus 70 per cent., and the average power required; therefore, $\frac{960}{0.746} \times \frac{100}{70} \times \frac{3}{10}$, or 550 h.p.

The fall of potential at the most extreme parts of the circuit at full load is made up of a fall of 1½ per cent. in the trunk mains, of 1½ per cent. in the 2,000 volt mains, and 2½ per cent. in the 100 volt leads, or a total of 5 per cent., this being compensated, however, by the increase of inductance of the transformers at high loads.

Since all the boiler power is only used for a small portion of the 24 hours' run, the alternate heating and loss by cooling and in cleaning fires make it improbable that a higher efficiency than 6lb. of coal per indicated horse power per hour can be got, there will thus be used 13,000 tons of coal per

annum, which, taken at 12s. per ton, costs £7,800. Allowing £2,200 for water, oil, stores, and steam for auxiliary engines, we have a total of £10,000 per annum. The wages for running the plant will amount to about the same amount—*i.e.*, £10,000. Allowing 10 per cent. for upkeep of engines, dynamos, boilers, and mains, a further £6,000 is required, and 20 per cent. on transformers and switches is £2,000, while 5 per cent. on buildings is £300. The total expense per annum is thus £28,300. If we further allow £5,700 for directors' fees, and write off £10,000 for depreciation of plant, the total outlay per annum is £44,000. The total number of units sent to the lamps is 2,470,000 per annum, and allowing 90 per cent. of this to be paid for at 6d. per unit, the annual income is £55,600. This allows a dividend of 14 per cent. on the £80,000 first cost.

(*b*) *Direct-Current System*.—Mechanical loss in 350-h.p. engines, 12 per cent.; mechanical loss in dynamos, 3 per cent.; electrical losses in dynamos, 5 per cent.; loss in five-wire leads, 2½ per cent.; loss in three-wire leads, 1½ per cent.; loss in double leads, 2 per cent.; or a total loss of 26 per cent.—the average efficiency of the system being thus, 74 per cent.; the average power required being therefore 520 h.p. through 24 hours per day. The fall in potential at the extreme parts of the circuit on full load is made up of a fall of 5 per cent. in the 400-volt leads, or 5½ per cent. in the 200-volt leads, and of 6½ per cent. in the 100-volt leads, making a total of 17 volts in 100. A large portion of this drop would be compensated by connecting the mains into a number of loops, but this method has the disadvantage that if a fault occurs, all the circuits looped with the faulty one have their lights out. It would be better to run one or two extra leads as feeders to the extreme parts of the circuit.

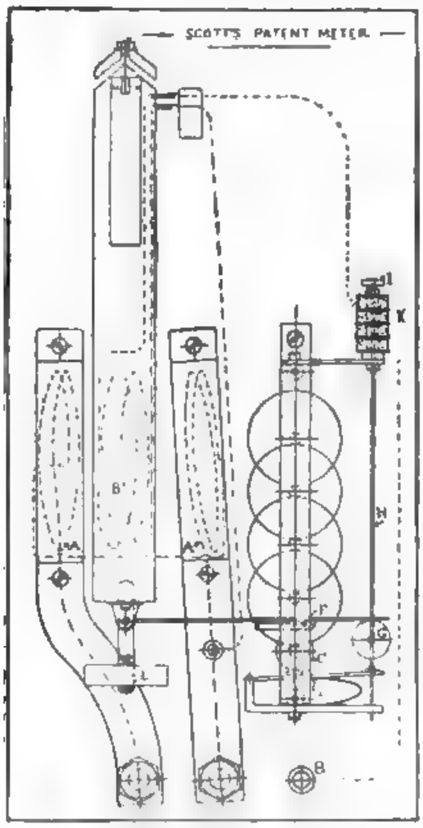
If engines and dynamos are worked only 12 hours per day, the batteries running the load from 2 a.m. till 2 p.m. the average power required will be 1,040 h.p., and we might have an efficiency of 5lb. coal per indicated horse-power per hour, thus using 11,000 tons of coal per annum, which, taken at 16s. per ton—the price in centre of area—amounts to £8,800. Allowing £2,200, as before, for water, oil, stores, etc., we have a total of £11,000 per annum. The wages for running the plant will be perhaps £1,000 less than in the former case, or, say, £9,000 per annum. Allowing 10 per cent. for upkeep of engines, etc., amounts to £7,000 per annum, while 20 per cent. on batteries and switches is £1,000, and £5 per cent. on buildings is £350; if, further, we allow £5,650 for directors' fees and write off £8,000 for depreciation of plant, the total outlay per annum is £42,000. Supposing the income £55,600, as in the former case, this allows a dividend of 15 per cent. on the £90,000 first cost.

I hope that the appearance of 14 per cent. and 15 per cent. dividends will not induce members into a wholesale purchase of electric lighting shares, for they must strictly observe that the conditions assumed are merely relative and not actual ones. I have assumed a favourable distribution; in practice, it is sometimes required to run half a mile of cable for 200 or 300 lights, and of sufficient size to be able to carry 10 times as many. The main reason why electric lighting companies are as yet unable to produce high dividends is that they require to put down buildings, plant, and mains of much larger capacity than is required for a number of years. If a corporation took up lighting an area, wired every street, and put a service into each house on the same principle as gas is supplied, then a system could be designed suitable to the requirements of the area, and with a fair density of lighting the cost would compare favourably with that of gas. As it would be inconvenient for me to be present at the discussion, I have entered into a more detailed examination of some parts than otherwise I might have done.

SCOTT'S ELECTRICITY METER TIMED FROM A CENTRAL POSITION.

The diagram shows a diagrammatic view of Scott's patent electricity meter, made by Messrs. Laurence, Scott, and Co., Limited, Norwich. As originally designed, a self-winding clock was included in each meter, which made it a somewhat complicated and expensive instrument, as the workmanship in an automatic apparatus of this kind must be very good. By doing away with the clock in each meter, and making one clockwork apparatus in a central position do for a whole lot of meters, a very simple and practical system is made, which, notwithstanding that a special meter wire has to be laid with the supply mains, works out cheaper in most cases than the ordinary system of meters.

The great advantage of the system, however, is that it enables the rates of charge for supply to be made different at different times of the day. This will be referred to further on. The meter itself is very simple, as will be seen from the diagram, which shows all the working parts. A A are the fixed series coils of strip copper, through which the current to lamps flows. B represents the movable shunt coil, whose resistance is about 1,500 ohms, with its terminal, B[1], for connecting to the special meter wire. C is the friction roller geared to indicating train. E is a brake to prevent C from being turned round otherwise than by the proper action of the meter. F is the friction



pad which, when lowered on to C, will communicate to that wheel any movement of the suspended coil, B. G is the roller on vertical carrier, H, which is lowered when the armature, I, of little magnet, K, is attracted. L is the adjusting weight.

The meter wires in connection with the shunt terminal, B[1], are periodically connected up to the lighting mains by the clockwork at the central position, or by a relay operated therefrom, so that a shunt current is periodically sent through the suspended coil, B, and through the little magnet coil, K, pulling the pad, F, into gear with the friction roller, C, and thus communicating the forward movement or "deflection" of the suspended coil, B, to the roller, C, this movement being exactly proportional to the current flowing in A A when the difference of potential at the terminals of the shunt is constant. When this shunt current is broken by the central clockwork apparatus the friction pad is lifted off the roller, C, before B commences its backward movement, so that the indicating train is only moved in one direction, and the various forward movements of B are integrated on it. The meter works on the most accurate principle that is known, and very careful experiments have been made to find out whether there can be any error from the way in which the principle is applied. It has been found that these meters, made as shown in the

diagram, have an accurate range of over one hundredfold, and this could be very much exceeded if there were any necessity for it.

The meter is generally arranged to give accurate readings in Board of Trade units, when the shunt circuit is completed every 90 seconds. The shunt current remains on for about 12 seconds. The central clockwork is arranged to make contacts one after the other with six separate circuits of meter wires, and as the resistance of the shunt circuit of each meter is about 1,500 ohms, there can be 45 meters on each of the six circuits, or 270 meters altogether, worked with a total shunt current of three amperes, so that $^7/_{20}$ or $^1/_{18}$ cable is amply large for the main meter wires, one branch wire of $^1/_{22}$ being taken from one of these meter mains to each meter in the customer's premises. For long distances and large numbers of meters a relay can easily be arranged in a junction-box, which will connect the next length of meter wire to the mains synchronously with the first length. The simplicity and consequent cheapness of this meter will more than balance the cost of the special meter wires in cases where the kind of mains employed permits of these being used.

If instead of sending a shunt current into the meter once every 90 seconds, this interval is increased to 180 seconds, the meters will indicate only half the current used. The clockwork at the central position can be arranged so that the alteration can be easily effected, and if the alteration from a 180 second period to a 90 second period is made, say, an hour before sunset by the almanac all the year round, and back again at some fixed time during the evening, it is evident that during the whole of the ordinary working hours in the summer, and the greater part of them during the winter, the current will be supplied at half-price, making the cost of power from electric motors compare favourably with that from gas engines. During these hours this will pay the supply companies, as, if they were not supplying this current, their plant would be almost standing idle.

It may be objected that this "power" load will overlap the "lighting" load, but during this time the current will be paid for at the lighting rate, and there will be many instances where consumers will arrange so that they do not use power at those hours in order to avoid paying the higher rate. It will also encourage the use of electric power during the summer time only, as there are many manufacturers who have steam power that they would gladly stop during the summer months, but which they prefer to run in the winter, as they utilise the waste heat for warming their premises. The shunt currents can easily be made to record themselves on suitably arranged paper marked with the time of day, so that the timing can be checked at any time.

FIELD MAGNETS.

BY GISBERT KAPP, M.I.C.E.

[By the permission of the author and the publisher we are enabled to give the following extract from Mr. Kapp's forthcoming treatise on "Dynamos, Alternators, and Transformers." We may add that the book will probably be ready early in January.—ED. *E. E.*]

The magnetic field within which the armature revolves may be produced either by the use of permanent steel magnets or electromagnets. The former are not so effective as the latter, and are only used in exceptional cases, notably in the older forms of machines for lighthouses and in very small dynamos, where simplicity of construction is of more importance than small weight—such as mine exploders, medical machines, signalling apparatus, and machines for laboratory work. There is, besides simplicity, a further reason for using permanent steel magnets in preference to electromagnets for very small machines, and this is that the energy required for exciting the magnets becomes inordinately great when the size of the machine is reduced beyond a certain limit, as will be shown later on. Machines with permanent steel magnets are known under the name of "magneto machines," whilst the term "dynamos" is more particularly applied to machines in which the field is produced by electromagnets. Since magneto machines have only a very limited sphere of application, we pass at once to the consideration of the field magnets of dynamos. The number of types of field magnets which have been used or proposed for dynamos is exceedingly great, but the difference between many of these is more apparent than real. It will therefore be best not to attempt to give a complete list of all the various designs of magnets, but rather select a few representative types for purposes of comparison. In any electromagnet we have to distinguish between two circuits, the electric and the magnetic circuit. These two must be interlinked, so that the current through the electric circuit may produce a flux of lines of force through the magnetic circuit, and the difference in type of dynamo field magnets is due to the more or less suitable arrangement of these two circuits.

Two-Pole Fields.—The most simple arrangement is that shown in Fig. 23. Here we have a coil of wire, W, interlaced with a ring of iron, R, cut open at G. If the gap G be made of cylindrical or tunnel-like shape, it may receive a cylindrical armature, and thus Fig. 23 may be considered as representing the field magnet of a dynamo machine, but on the whole not a good arrangement. In the first place, the length of wire in the coil is unnecessarily large, and this can be reduced by laying the wire more closely round the iron ring, and spreading it over a great portion of it. In the next place, the curved form of magnet is bad from a practical point of view, partly because a forging of this kind is difficult to produce and to

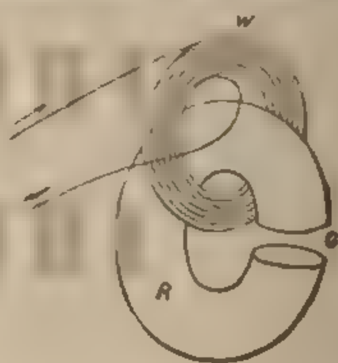


FIG. 23.

fix in the frame of the machine, and partly because it cannot be wound in the lathe. It has been shown in Chapter V. that neither the shape of the core nor the disposition of the exciting wire have a direct influence on the magnetic flux produced by a given exciting power, and we are therefore free to alter the shape and arrangement of the magnetic and electric circuit in such manner as may be convenient. Instead of a bank of wire we may thus use a cylindrical coil wound on a former in a lathe, and instead of the curved iron core we may use a core consisting of straight pieces, which are more easily forged, machined, and put together. We may also make the pole pieces detachable from the magnet core proper if by doing so we obtain some advantage as regards manufacture, but in this case we must take care to fit the different parts of the magnetic circuit properly together so as not to impede the flow of lines when it passes from one part to the next. In this way we arrive at something like the design shown in Fig. 57a. M is a straight cylindrical magnet core of wrought iron shouldered into the cast iron pole pieces, P P, and C is the exciting coil.

It will be seen at a glance that this arrangement is electrically and magnetically equivalent to that shown in Fig. 23, but mechanically it is a great improvement. The design is simple and substantial, all the machining can be done on a lathe or boring machine, and the coil may be wound on a separate frame and slipped on when the machine is put together. This winding of magnet coils separately is important, not only because of facility for repairs, but chiefly because it is possible to keep the electrical and the mechanical part of the work in distinct departments. If the coil is wound directly upon the magnet core a much greater weight has to be handled and there is a risk of the insulation being injured by metal

chips or filings, which are necessarily present in a shop where machine tools are at work and fitting is going on For this reason it is best to do the winding and other electrical work in a separate shop.

The design of magnet shown in Fig. 57a, although, as was already said, perfectly practical, is still capable of improvement in two ways. In the first place, the magnet being on one side of the armature, the field is slightly unsymmetrical, and in the next place the arrangement is very heavy. Both of these defects can be remedied by duplicating the magnetic circuit, as shown in Fig. 57b We require now two exciting coils and more wire, but we obtain, on the whole, a lighter machine, and one in which the field is perfectly symmetrical.

The field magnet, Fig 57a, has another defect, inasmuch as the coil is short, and has therefore only a small external surface through which the heat generated by the

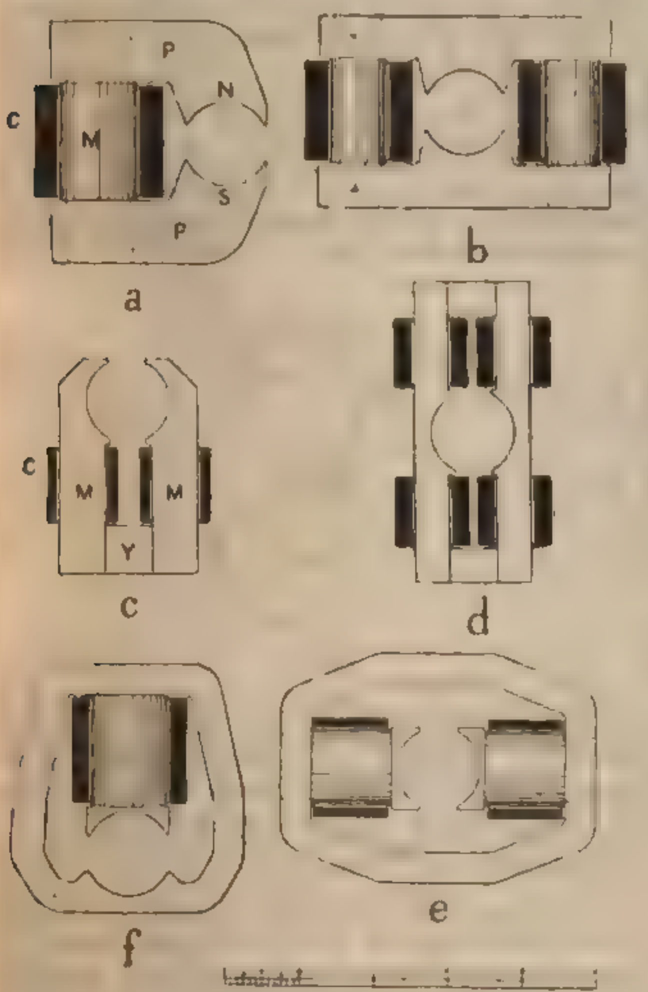


Fig. 57.

passage of the current can escape. Practical experience has shown that for every watt absorbed by the resistance of the coil there must be provided a certain area of cooling surface, if the temperature of the coil is to be kept down at a safe limit. Authorities differ as to the exact number of square inches of cooling surface required per watt of energy dissipated, and it is obviously impossible to lay down a hard-and-fast rule, as the disposition of the machine, with regard to the fanning action of the armature and the locality where the machine is used, must necessarily influence the rate at which the coil can dissipate heat, but, generally speaking, the cooling surface should not be less than one square inch and need not be more than four square inches per watt. To prevent the coil, in Fig. 57a, from becoming too hot, we must, therefore, either increase its external surface by making it longer and shallower, or we must put more copper into it. The first expedient is of doubtful value, as it leads to a much heavier field, and the second is expensive. We can, however, alter the design altogether so as to obtain enough cooling surface without increasing the weight of the field. We need only treat the part marked M as the yoke, and put coils on the two limbs marked P P in Fig. 57a In this way we obtain the design shown in Fig. 57c, which is a very favourite type. By putting two exciting coils on the magnet limbs, M M, we have not only increased the cooling surface, but have also materially decreased the whole weight of the machine

This design is known as the "overtype" field. By reversing it—that is, putting the armature below, and the yoke, Y, at the top we get the "undertype" field, which is also much in use, and is specially adapted for direct-driven machines, where it is important to get the spindle low down to correspond with the position of the engine shaft. In this case the machine is supported from its pole pieces by brackets or packing pieces of non-magnetic material. In the overtype these pieces are not required, and the yoke may be either bolted direct to the bed plate or may be cast in one piece with it.

This type of field, although lighter than the previously described types, is still rather heavy if the diameter of the armature is large in comparison with its length. If such an armature must be employed, and if it is important to save weight, we may duplicate the field, and thus we obtain the type shown in Fig 57d. This contains less iron than the overtype field, but more copper, and, although, on the whole, it is considerably lighter, it is also more expensive.

Figs 57e and 57f shows fields of the "iron-clad" type. Their characteristic feature is that the yokes surround the magnets completely. There is consequently no stray magnetic field. Fig. 57e is very heavy, but requires little wire, whilst Fig. 57f is not quite so heavy, but requires more wire.

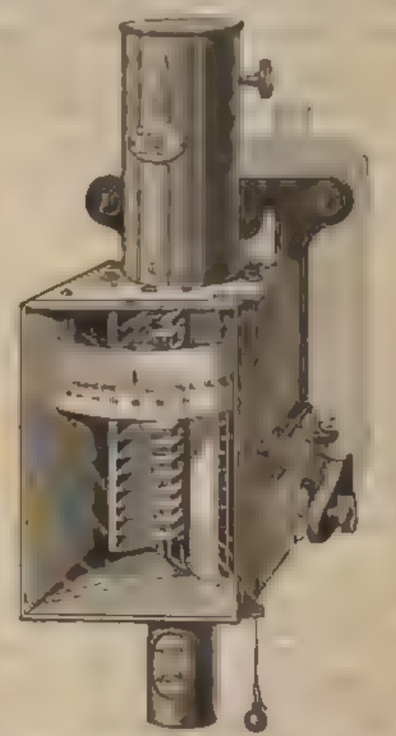
To give at a glance an approximate idea of the amount of copper required in each type of field, the space occupied by the coils is shown in black. The fields are all designed to take the same size of armature—namely, a drum 12in. diameter by 15in. long.

(To be continued.)

TRADE NOTES AND NOVELTIES.

LORD KELVIN'S NEW FORM OF ELECTROSTATIC VOLTMETER FOR LOW VOLTAGES.

The arrangement of the vanes and cells of this instrument are much the same as those of the multicellular voltmeter



already described in these columns. The instrument is specially designed for use on switchboards, and has a vertical scale instead of the old plan of reading with a mirror It is rendered practically dead beat in its action by a small horizontal disc, which turns in an oil dashpot below the case. The zero adjustment has been much improved by the addition of a torsion head and micrometer screw.

THE

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HIGH AND LOW PRESSURE.

It is easy to foretell the gist of a report when the reporter's name is given. Thus, Prof. Ayrton's report to Cheltenham could easily have been written by a plagiarist possessing fair ability and a fund of good common sense. The report, as will be seen, proceeds upon general lines, and except on one or two points is such as can be generally subscribed to by everybody. We do not think his estimated calculation of the difference of the first cost of plant, when considering transforming by accumulators, motor-dynamos, and alternate-current dynamos, is correct. Further, we do not think the tabulated statement as it stands is a fair one to put before users in order to influence their opinion one way or another. Ten thousand times too much is made of prime cost, and ten thousand times too little of maintenance. Again, prime cost is not restricted to accumulators or motor-dynamos, but must be considered of the whole system, and it may be that by using some one of accumulators, or motor-dynamos, or alternate-current transformers the prime cost of other parts of the apparatus may be considerably reduced. Probably Mr. Crompton would say, and try to prove, that the prime cost of the whole apparatus was little, if any, greater with accumulators than with other kinds of transformers. If figures of the kind mentioned are to be given, they should be complete. The second point we should like to express an opinion upon is that relating to 100 or 110 volt lamps, and the saving of cross-section in mains by using the latter. Why stop at 110 volts? Is there now to be uniformity of practice? Recently it has seemed as if we were settling down to a uniform use of 100 volts pressure. Now it is suggested Cheltenham should have 110 volts; to-morrow it may be suggested that some other town have 120, and so on. Makers of apparatus desire to have stock patterns, and by making to stock supplying orders straight off the reel; but if there is no uniformity such a state of things is impossible. It will be seen that we have nothing to say against 110 volts, or any other particular pressure, provided everybody adopts it. The lampmakers might suggest that the greater the uniformity of lamps the greater the probability of getting the best possible lamps. There will still be plenty of room left for the services of the consulting engineer even should the uniform pressure at the house terminals be 100 volts. The great feature of the Cheltenham scheme is that the design starts with a definite view to use the waste heat of destructors, and if carried out will be the first systematic attempt to do this for electric lighting purposes on a large scale.

Mr. Buchanan's paper to the Physical Society of Glasgow, given elsewhere in our columns, comes as a welcome contribution on the subject. No doubt objections will be found to some of the figures, but as with Prof. Ayrton's report, we shall refer to one point—the assumption as to the percentage of units paid for of those sent out. Far too little authentic information is forthcoming on this, but what little there is shows Mr. Buchanan's percentage to be rather too favourable. Gradually we are

getting at what may be termed the average cost of generation per unit, an exceedingly important subject, especially to engineers, but, as with the distribution of gas, the number of units generated and the number of units paid for are separated by a tolerably wide gulf. How wide or how narrow is what the shareholders want to learn.

THE ELECTRIC CONSTRUCTION CORPORATION'S NEW ISSUE.

The ordinary general meeting of the Electric Construction Corporation is held to-day, and no doubt much interest will be exhibited at the meeting, but as we necessarily have to write before the meeting the results cannot be given in this issue. However, two very tangible documents are before us, either of which is worthy of a sermon—the balance-sheet of the corporation, and the prospectus of a new issue of £100,000 second mortgage debentures. Long ago we expressed our opinions as to the finances of the corporation, and those criticisms have by lapse of time been justified to the letter. We prefer in the present instance to take things as they are, and the conclusion to which one must come is that under the able management of Mr. Parker the corporation has a fine business at Wolverhampton. A concern whose production reaches £175,276 a year is of no mean importance, and is worth holding at considerable hazard. The balance-sheet at this time last year showed output £160,036, while that of two years since can hardly be taken into account, being the first issued under the company's auspices, showed, however, an output of £222,734. These are big figures, and under any circumstances in a properly-conducted business should show a good profit. It rests with the shareholders to enquire into the causes that have necessitated the issue of further debentures, though, no doubt, it is difficult to bring home effectively any remedy. Some one or two directors are made scapegoats, and promises as to future economy are promised. Let us see how the debenture-holders will stand. The present debenture capital is £125,300, the new issue is £100,000—a total of £225,300. The net profits from an output of £175,000 should be ample to pay interest on this amount, so that the issue seems, from a financial point of view, quite warranted, and perfectly safe. The ordinary shareholders are in a troublesome position, but have nothing to gain and may have much to lose by impatient criticism at this moment. After the meeting we may have something to say on the question of their position.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BALANCING ARMATURE REACTIONS.

SIR,—In your issue of December 2nd there is a reprint from an American paper on this subject. The sentence explaining (!) number of balancing turns seems to me to be very obscure: "The product of the armature conductors under a pole into the current in the same is equal to the product of the balancing conductors back of each pole-face in the current (total armature current) through them." Perhaps some of your readers will be kind enough to translate this for me.

I also fail to understand how 58 grooves each ⅝in. wide, = 36·125in., are cut in a core only having a circumference of 22 55in. Or how 100 volts are obtained with 290 wires cutting 400,880 lines at a speed of 60 revolutions per second. I am not writing this with an idea of carping, but to obtain information.—Yours, etc.,

THOS. HY. PADGHAM.

7, King's-terrace, Basford, Stoke-on-Trent,
December 12th, 1892.

THE PRICE OF ELECTRIC SUPPLY.

SIR,—The interesting letter from Mr. Bromley Holmes in your last issue shows very clearly the disadvantages of basing a sliding scale of charges upon the maximum demanded supply when this is taken to mean simultaneous supply to all the lamps, etc., fitted on the consumer's premises. Neither does it appear that the use of a maximum current indicator in connection with each consumer's meters, as suggested by Prof. Kennedy, would quite meet all the difficulties.

We may suppose that by using the heating effect of the current to operate the indicator, or by the use of a dash-pot, the indicator could be made to move so slowly as to prevent the record from being seriously affected by such a momentary current as would be necessary to blow a fuse. Otherwise an accidental short circuit might considerably increase the price per unit for that unfortunate consumer for a whole quarter, and thus lead to undue friction with, if not to sparking at, the collector. It may, however, be said that the ultimate effect would be desirable, inasmuch as it would tend to the more general adoption of such arrangements as would almost abolish the chances of short circuits on any but the smallest branches—*i.e.*, at the lampholders, etc.

We may further suppose that the indicator would be reset at the proper time only, and after its reading had been duly noted by a trustworthy inspector. Even then this system of charging does not always tend to produce the effect to be desired alike in the interests of the supply company and of its consumers—viz., a large load factor.

For instance, churches requiring supply on Sundays only would have to pay the highest rate, but it would be to the interest of the supply company that the rate should be reduced on Sundays in order to develop demand when a large part of the plant would remain idle if the higher price prevailed.

Similarly, during the two summer quarters business places and many other customers would have to pay the higher rate. The demand would thus be repressed in the summer time, when, in the interests of the supply company, it should be developed by reducing the charge. Shop windows would probably be kept alight if supplied at a lower rate after business hours. Motors also would be more extensively used for intermittent work and purposes requiring supply for only one or two hours daily, if the supply were charged always at a low rate, excepting during the time of heaviest demand for lighting purposes. This would frequently result in arrangements being made by consumers to avoid taking supply just at this time, thus increasing the load factor.

From the concluding clause of Mr. Holmes's letter it might be supposed that in matters which affect the system of charging there is no essential difference between the supply of gas or water and the supply of electricity. It may therefore be well to refer to the differences. For convenience, let that portion of the total annual cost which is made up of interest on capital, depreciation, and such other expenses as vary very little with the duration of the demand, be called the fixed expenses.

In the supply of gas and water, owing to the cheapness of storage and the large variation which is allowable in the pressure at the consumer's terminals, a comparatively small increase in the fixed expenses enables the produce of the machinery to be delivered to consumers at 10 times the rate at which it is produced at the works.

In the case of electricity, owing to the lack of any efficient means of modifying the pressure, such as would be

equivalent to the reducing valve commonly used with branch gas pipes and burners, it is necessary to maintain the pressure constant within very narrow limits at the consumer's terminals. For reasons well understood the fixed expenses are proportional, not to the greatest consumption during a period of, say, two days, as in the cases of gas and water, but to the maximum rate of supply provided for, although this rate may be demanded for less than one hour in the year.

Consequently the problem of charges for supply is essentially more complicated in the case of electricity than in the case of gas and water, and the central stations which are able to vary their rates of charge in such a way that their customers reap the benefit of so fitting in their demands as to produce a large load factor will, other things being equal, pay better dividends and develop a larger and more varied demand than the stations with a fixed scale of charges.—Yours, etc., W. B. SISLING.

RE FIRE AT LONDON STEREOSCOPIC COMPANY.

SIR,—Mr Heaphy, in his letter of 6th inst. in your last issue, has taken an exaggerated and erroneous view of my letter to your contemporary. I made the remarks on what I believed to be reliable authority, but as I am not permitted to publish the names of my informants I am bound to withdraw the remarks and express regret for publishing them.—Yours, etc., J. D. F. ANDREWS.

41 and 42, Parliament-street, S.W., Dec. 13.

ECONOMIC POSSIBILITIES OF THE GENERATION OF E.M.F. IN THE COALFIELDS, AND ITS APPLICATION TO INDUSTRIAL CENTRES.*

BY B. H. THWAITE, C.E.

(Continued from page [illegible].)

Artificial Lighting Power Distribution.

The author, in his report on "The Distribution of Fuel Power Gas," demonstrated† that, comparing the cost in value of heat units represented by a given volume of gas for the production of a specific luminous value, the incandescent lamp driven with a gas engine (Otto cycle) is 50 per cent more efficient than a batswing gas burner. This is clearly shown by the graphic diagram. Of course, compared with the recuperative gas burner, the advantage is on the side of the gas. If the price per B.T.U. is reduced to 3d. per unit, the financial advantage will then be entirely in favour of electric energy. A glance at the comparative graphic diagrams, Fig. 2, which the author has drawn up from reliable data, shows clearly that as the cost of production approaches more nearly to that of the admirable Bradford Corporation electric lighting installation example, the reduction of cost of supply will be such as to permit the electric light to be not only the ideal and beautiful light of the fortunate few, but that it will become the ideal and cheap light of the many.

The reports of the cost of transmission given in the appendix show that it will be possible to supply E.M.F. to the metropolis at a price as to permit the electric light supply companies to distribute the light at such a reduction as will permit it to be economically used in comparison with gas, as ordinarily burnt with open flow batswing burner. Of course, it will be unreasonable to expect the electric light companies to be able to reduce their price until the outlay in ways, trunks, and leads shall have become fully utilised; then, with a cheap source of energy, the reduction of cost will follow. In two years or sooner the patent rights relating to the use of incandescent lamps will have expired, and this will alone reduce the cost of the lovely electric incandescent light by at least 10 per cent. Hence, if the electric energy is supplied from a great central coalfield generating station, and its pressure is reduced down to the required voltage of the different town supply companies, the electric light will soon find its way into the cottages of poor and rich alike.

The Metropolitan and Greater London Lighting Companies.

Thanks to wildly reckless speculative and immatured projects, born of greed and inexperience, and the original legislative enactments relating to electric lighting, progress in London has been up to recent times practically crippled; but the lethargy resulting from early disappointments has cleared away like mist before the sun, whose power the electric light surely is, and to-day the metropolitan companies in active operation have already a capital of over three millions sterling, or one fourth of that of the gas companies of Greater London. Up to the last month, over 33 miles of service mains have been laid, and 90 miles of [illegible] been drawn in, and the plan of the giant city shows that [illegible] electric girdle practically embraces the main part of the metropolis, and is sufficient to supply some 360,000 lamps. One company, the London Electric Light Company, Limited, with a [illegible] of £600,000, has already applications for 40,000 8-c.p. incandescent lamps, and 16,000 are already fitted, and it is estimated [illegible] net revenue from the 40,000 lamps will alone be more [illegible] adequate to pay interest on the share capital. In Paris, also, the recent development in the use of the electric light has been very striking and remarkable.

The Choice of the Motive Power Generating System.

One of the fundamental requirements in the choice of a motive power generating system, is a means of rapidly throwing off the total load of work without involving any waste or danger. Where the source of power is the natural waterfall, it is of course, unimportant if the load is suddenly taken off, but with a steam engine plant the sudden stoppage of the engines throws the whole of the generated steam back on the boilers, [illegible] a sudden rise of steam pressure. Besides, the residual heat of the water and fuel is practically lost if the stoppage is for any length of time; and if the power demand is sudden, unless the steam power is continuously kept up, this condition cannot be fulfilled. An ideal method of motive power generating [illegible] should permit the full power of the plant to be obtained in [illegible] minutes at the most. It should also be possible to [illegible] the entire dynamic plant out of action without involving [illegible] strain on any part of the plant; and the whole time [illegible] the plant is in action it should be performing useful work. [illegible] one who understands the characteristics of the two [illegible] and gas engines, will recognise that the only kind of [illegible] able is the gas engine one driven with its own cupola [illegible] fuel gas. There are other considerations in addition [illegible] already mentioned that are of essential importance in [illegible] the ideal system. The fuel power plant should be of [illegible] character that as high a thermo-dynamic efficiency as [illegible] shall be obtained.

The author has tested the relative efficiencies of the gas and steam plant. The economical dynamic fuel power for [illegible] large powers is the gas engine. A consideration of [illegible] economy compels one to insist, as a sine quâ non, that for large powers, in which the consumption of fuel is high, the [illegible] lisable hydro-carbons and the nitrogen associated with hydrogen shall be recovered. Of course, this involves the conversion of [illegible] fuel into a gaseous condition, and this desideratum can be [illegible] with either a steam engine or a gas engine; but it must be [illegible] to the veriest tyro in the science of thermo-dynamics, and [illegible] not be too often reiterated, that the gas thus produced should be burnt in the motor cylinder, and the heat thus directly converted into motion in preference to burning the gas in a steam boiler, which is only too often a monument of inefficiency. In the [illegible] of misty fog suddenly rising the whole of the gas engines [illegible] could be immediately started because the storage of power gas in the gasholder can be established for any length of time without involving any appreciable heat loss or expenditure of labour, and can be utilised by simply the turning of a valve. When any portion of the load is thrown off, an equivalent power gas engine is instantly stopped, and the gas energy flows into the holder until required. The author suggests the replacement for large installations of storage batteries, with gasholders, for the storage of a convertible form of energy, available for use at a [illegible] notice, and involving no loss of energy by storage, for however long a time. Therefore it may be accepted as an axiom, that the ideal fuel power dynamic plant is the internal combustion engine driven with fuel gas stored in a holder, and from which the nitrogenous and other chemical assets have been recovered.

The author and Mr Swinburne in the projects to be described have adopted a character of plant as the ideal method of generating fuel power at the coalfield motive power generating stations composed of the following constituent elements:

1. A gas generating plant of the cupola type, fitted with automatic fuel feeding devices and automatic [illegible] arrangements. The fuel is fed by an electric overhead [illegible] suspension way, or by means of an ordinary electric [illegible] system to coal bins from which it is elevated to the [illegible] and by electric driving gear is then transferred to each cupola.

2. The gas generated is then led through a battery of condensers, in which any atomised fuel carried over with the gas is caught and by which the ammonia is separated as well as the tar. The purified gas is then led through scrubbers of the tower type filled with coke or brushwood, from which the residual tar and ammonia is finally removed. The sensible heat of the gases is then recovered by special means.

3. The gas is then led to the gasholder, and is stored for use. This advantage displaces the necessity for storage batteries. When the holder is raised to a certain height, it automatically turns off the gas generating plant by degrees. A sufficient capacity for emergencies is always provided for.

4. The ammonia water is treated with sulphuric acid by the formula $2NH_3 + H_2SO_4 = (NH_4)_2SO_4$, and the sulphate of ammonia recovered is intended to be sold for agricultural purposes.

Comparative Efficiencies of Internal Power Transmission Arrangements.

The importance of the subject of the transmission of dynamic force to motive elements constituting the industrial plant, has [illegible] quite recently received some of that recognition which it deserves.

* Paper read before the Manchester Association of Engineers.

† "On the Distribution of Fuel and Power Gas," by B. H. Thwaite (*Journal of Gas Lighting, Gas World, and American Manufacturer*, 1892).

The absorption of energy by shafting and belts is not even now properly appreciated. It is only when the dynamometer has been applied, and, better still, since direct driving by electric motors has displaced shafting, gearing, and belting and other methods of driving generally in use, that power users have realised the degree of ceaseless waste in their methods of power transmission.

The displacement by direct electric driving of ordinary shafting and belting methods has resulted in the reduction of power absorption very considerably. M Sarteaux, engineer of the Chemin de Fer do Nord, has recently introduced electric driving at the locomotive workshops at Creil, and he has informed a mutual friend that he has realised a saving in power of 50 per cent. This friend, in a letter, tells the author that some investigations carried out at the Fabrique d'Armes de St Etienne proved that with their then shafting and belting methods of power transmission, not more than 7 per cent. of the power consumed is utilised in doing actual work.

What is the explanation of this extraordinary waste which, if summed up for all our industrial applications, would almost turn the hair of our patriot economists grey? One may venture to suggest an answer: The main shafting, having a potential of dynamic energy equal to the maximum requirements, is always in motion, each bearing surface in its length having a function of energy absorption depending in value upon the character and nature of the frictional surface. Each location of transmission by belting to countershafting is also a point of energy absorption whether the effective part of the producing plant is in operation or not. In dust producing workshops the friction produced by the deposition of dust on the bearing surfaces is alone a factor of explanation, and the loss of efficiency by imperfectly light and

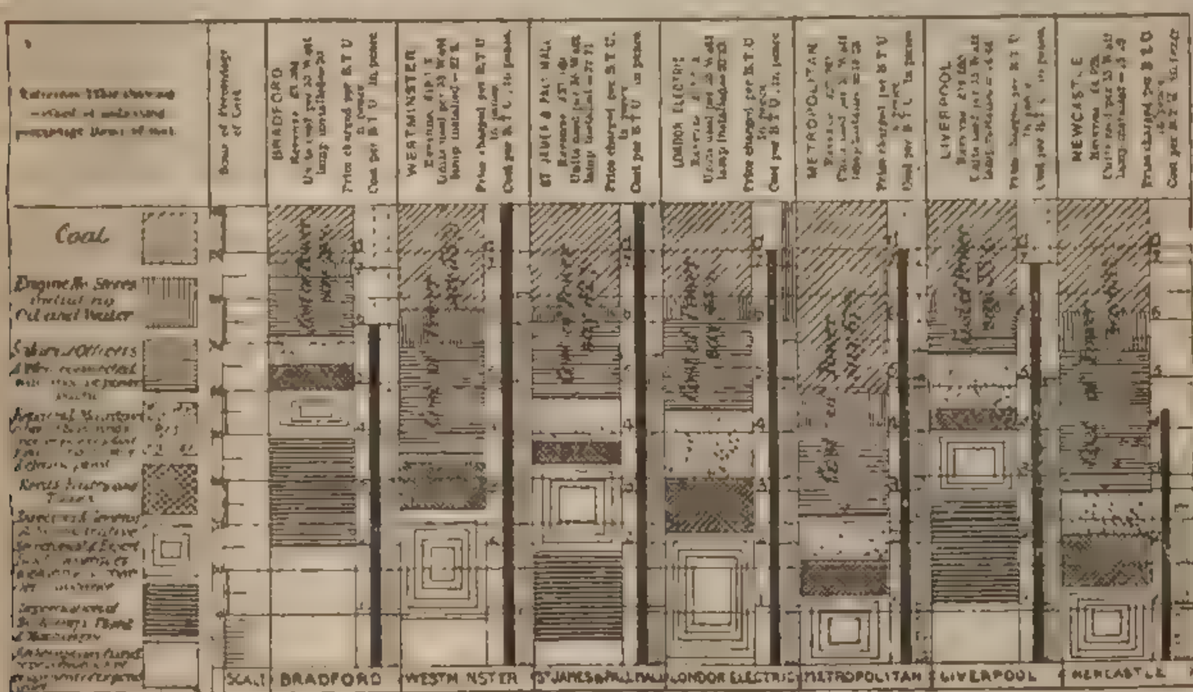

Fig. 2.

unsuitable belting and intra methods of power distribution is also another factor. The gearing elements for diverting the line of power transmission are also absorbers of energy. Individual machines absorb much less power than is generally supposed, and the author urges every power user to ascertain precisely the amount of power absorbed by each of his machines. He would then be cognisant of the running loss by which he is the sufferer.

Since the author wrote the above he has seen the advance proofs of Mr Saxon's useful paper. Mr Saxon pertinently remarks that if the coal consumption were based on actual work done it would give some startling results. There is little doubt but that M Sarteaux's happy experience of a power saving of 50 per cent. by the application of direct electric driving would be experienced by many engineering workshop owners. In Mr Saxon's summary of tests it appears that the average energy absorption percentage for

Spured geared driving is	25·9
Rope geared driving is	29·6
Belt geared driving is	28·6
Direct coupled driving is	23·835

giving a total average of 26·983 per cent. of energy absorbed in internal power transmission work.

On referring to the loss of energy in electric transmission methods, it will be realised that for any ordinary works there would be practically no loss of energy between the motor and the subsidiary industrial machine. The relatively high speed of electromotors is unfortunately not appropriate to existing stationary tools except by the employment of reducing motion pulleys; but there is no obvious reason why the electric motor should not be applied direct to each new and convertible machine, the speed being reduced by helocoidal or other appropriate gear, to satisfy the requirements of the industrial operation. Granting this desideratum, we have at once an ideal method of transmission which has the following series of valuable characteristics:

1. Each industrial machine can be easily and instantly thrown out of dynamic action by the simple touch of a switch.
2. The loss of efficiency in power transmission from the parent motor is almost negligible.
3. No lubrication is involved, nor expensive lubricants.
4. The dangers associated with belt shifting and belting set forth graphically in the author's work * "Our Factories, Workshops, and Warehouses," is entirely removed.
5. In the event of an accident the machine can be instantly arrested.
6. As the power demand is cut off the power supply is reduced in the same ratio.
7. The position of the machine can be altered in any direction considered convenient, without involving the consideration of its effect upon the line of transmission.
8. The danger from fire through over-heated bearings is reduced in a degree depending upon the quality of insulating workmanship and upon the character of the fusible cut off.

The employment of internal electric transmission has been in no instance in this country more fully put to regular use than by the famous firm at Wolverhampton, the Electric Construction Corporation, Limited, and for this progressive action we may thank Mr Thomas Parker, than whom there is no more enthusiastic advocate of the practicable advantages of electricity. Thanks to the courtesy of this firm, we are enabled to realise the extent of their practical patronage to electrical methods of power transmission. The full particulars are given in the appendix; but it may be stated here that with the exception of one defect, that of the retention of intra or subsidiary shafting and belting, the whole of the power is transmitted electrically. The motors are distributed over four acres of ground, the same cables distributing and transmitting the current for the motors also supply the arc and incandescent lamps for lighting the works. All the machine tools, with the exception of a large planing machine and circular saw (which have a motor of their own) are driven from shafting rotated electrically. The 10-ton shop crane is also electrically driven. The cranes travel up and down the shop at the rate of 50ft. per minute, and cross the shop at the same speed. The electric transmission plant has now been running for two years. So far, there has not been any accident, and beyond the usual brush renewals for generating machines and motor transmitters, there have been no repairs required. The firm completely relies on its motors, and has not provided any other means of driving the tools. Not having driven the works by the ordinary methods, the firm cannot make any direct comparison as to power required, but the secretary writes that there is no doubt but that a comparison would come out largely in favour of the electric method.

The De La Vergne Refrigerating Machinery Company, of New York City, have applied in their new works the electric method of transmitting power. They drive their extensive series of planing, slotting, and drilling tools by separate motors of approximate size, gearing down by countershaft and belt; even with this disadvantage they consider that at least 7 per cent. of efficiency is gained, and the cost of maintenance is considerably less.

* "Our Factories, Workshops, and Warehouses: Their Sanitary and Fire Resisting Arrangements," by B. H. Thwaite. London: E. and F. N. Spon, Charing Cross.

The Influence of Electric Transmission of Energy, if generally adopted, on the Atmosphere and on the Conditions of Life in Industrial Centres.

Anyone living in a purely agricultural locality, or in towns like Paris, where the ambient atmosphere is free from the polluted emanations from industrial processes and having the misfortune to be compelled to remove therefrom to towns like Manchester, Bolton, or Oldham, must have been struck with the phenomenally high rainfall average of these towns, and will have noticed the characteristic oily condition of the atmosphere especially on wet and foggy days, and the greasy condition of the pavements. Without going so far as Ruskin, one is compelled to admit that any industrial operation that tends to interfere with natural actions by polluting the atmosphere and altering its degree of humidity, should be carefully looked into, to ascertain if the evil cannot be extirpated. The atmosphere of Manchester having only a moderately high hygrometric character, acts nevertheless in the nature and with the effect of a condenser for the immense volumes of steam sent into the atmosphere from thousands of exhaust pipes, until the ultimate or saturation point is reached, and the atmosphere being unable to hold in suspension this added aqueous vapour, it is released, and the inevitable rainfall of Manchester follows, bringing with it the hydro-carbons belched forth from hundreds of chimneys. These hydro-carbons, along with the lubricant particles associated with the exhaust steam, explain the greasy condition of the mud in the Manchester streets. How different is the early Sunday morn of these industrial centres! Every observer cannot fail to be impressed with the metamorphosis of the atmosphere.

The general distribution of electric energy for light and power, with fuel gas as the general heating agent, would go a long way towards clearing our industrial centres from these depressing conditions, so inimical to healthy vigour of mind and body and lightheartedness, and which conditions, so absurdly out of harmony with the characteristics of our once Merrie England, are not entirely free from responsibility in the cause of our national shame of drunkenness. How different the Manchester of the once great Venetian republic! There the resultant wealth from the sale of the products of the looms of Lombardy actually adorned Nature, and the architectural beauties of the Venetian industrial centres are to-day the joy of all art lovers, in almost spotless condition, except that charming tint due to antiquity; whereas the sculptured work in our industrial centres, as in the instance of Manchester, is simply a hideous caricature of the ideal of its architect-creator. The general distribution and use of electric power as proposed, along with the general employment of gas as the heating agent, would clear away this stigma from our cities and towns, and with it the dirty envelope of soot that, once removed, would, let us hope, never be allowed to clothe up like a deadly pall the beauties of art in stone.

The Hygienic Economy.

The author demonstrated before the Demographic Section of the Hygienic Congress* that the expenditure in making any process or operation of industry thoroughly healthy was money well expended. There is little doubt but that the facility of inducing currents of air, by means of electrically propelled fans removes one of the disadvantages of the electric light, compared with the scientific system of gas burner; but, of course, the electric incandescent (in vacuo) light is far superior hygienically to the naked gas burner. Comparing the two lights calorimetrically, it will be seen that the heat produced for a given lighting or photometric value is far greater in even the scientific or recuperative gas burner than in the incandescent lamp. Besides, with the latter system, there is not the slightest pollution of the atmosphere. These are important advantages, because no cause is more prejudicial to vigour than expanded air resulting from an abnormal temperature. The weight of air (oxygen) passed through the lungs is relatively less, and there is a drop in the animal vigour. The work done is less, and of inferior character. With the distribution of electro-dynamic energy, a simple transformer attached to the service conductor will reduce the potential to the desired voltage degree, either for arc or glow lamps. The increased vigour of the workpeople, due to the pure and relatively thermo-neutral light, its semblance to the natural solar light in its actinic effect, will justify the employment of electric lighting alone, independently of the money value saved. It has been conclusively proved in our Government offices that labour is more efficient and the number of employés can be reduced, by the employment of lighting by electric energy. The question of economy is dealt with elsewhere.

It may, however, be expected that a greater luminous value, as 2·4 is to 7·7, can be produced by burning lighting town's gas in a gas motor, and converting the dynamic into electro-luminous energy, than in burning gas direct by a batswing burner. *Verb sap.*

The Value of a Supply of Economic Electric Energy to Agriculture and Floriculture.

The cultivator of flowers, fruit, and vegetables has a friend in one of the characteristics of the voltaic arc light. This illuminant has an actinic, or chemically active light effect, analogous to the light from unimpeded sunlight. This chemically active characteristic is the motive influence that initiates and stimulates organic life. Ordinary artificial light from gas cannot be said to possess any electro-chemical influence. In the arc light we have nearly all the conditions that could be desired for the cultivation of fruit and flowers. The sun is very sparingly permitted, by the conditions of our climate, to give us a bountiful supply of his invigorating electro-thermo-chemical energy. This has been proved by tests with actinically sensitised paper.

The influence of unimpeded sunlight is brilliantly shown in sunny California, where vegetable organic life is almost wantonly vigorous. It has long been known, since Sir W. Siemens's original experiments in this direction, that the electro-chemical energy of the arc electric light is beneficial to the life and vigour of vegetation, but this beneficent advantage has only recently been put to actual industrial use; and again we have to point to the progressive American for the initiation of a practical commercial application of electro-chemical or actinic luminous energy for the rapid night rearing of fruit and flowers. Were the main high-power electro-conduction trunk lines laid down through the heart of agricultural and pastoral England for the distribution of an additional supply of electro-chemical energy for a line of fruit and flower areas of cultivation, the benefit that would accrue, if properly and adequately utilised, would be an adequate justification for the expenditure. Instead of the ordinary single crops, two, three, and even four crops might be obtained; and instead of our having to import fruit, there should be an excess over internal consumption that would permit an external fruit export trade to be opened up, not to mention the advantages to floral and horticulture.

The Three Projects of Power Transmission.

The author and Mr. James Swinburne have drawn up one report of a project for transmitting power from the South [illegible] shire coalfield to the metropolis. This report is given [illegible] in the appendix, and is shown clearly on the plan of [illegible]. It is, of course, obvious that the same trunk lines [illegible] can be utilised for serving the large towns *en route*, [illegible] Derby, Nottingham, Leicester, Northampton, and Bedford [illegible] suggested that an auxiliary generating station shall be [illegible] South Staffordshire, the trunk line from which shall serve Wolverhampton, Birmingham and the industrial areas in the [illegible] route across to the point where it joins the main trunk [illegible] serving the metropolis.

Two alternate specifications are given in the appendix, one [illegible] Oerlikon Company, Maschinen Fabriken Oerlikon, to whose [illegible] (M. Emil Huber) the author is indebted for much valuable information, and the other is contributed by Messrs. Brown, Boveri, and Company, and Mr. Charles Brown.

The two other projects are for supplying E.M.F. to the [illegible] industrial centres of Lancashire and Yorkshire. For the Yorkshire one the central generating station is located near Barnsley. The direction of the main trunk lines is clearly indicated in the [illegible] transmission. It will be seen to serve the industrial areas between Chesterfield and Sheffield in the south and Leeds in the [illegible], serving the Batley and Dewsbury district *en route*. A branch [illegible] line serves Huddersfield, Halifax, and Bradford, and the adjoining industrial areas.

The loss of efficiencies in the different trunk lines is a negligible quantity, and the interest on cost of mains would almost be [illegible] by the mere cartage to the station in many instances, besides the great advantages already set forth.

The Lancashire project generating station is located near Wigan, and here it may be mentioned that as the great power stations are all proposed to be located in the centre of the coalfields, this would enable the different colliery owners to obtain on [illegible] terms the unquestionable advantage of electro-dynamic energy for traction, pumping, winding, lighting, coal getting, ventilating and drilling purposes.

One trunk line from the Wigan station will serve Bolton, Bury, Heywood, and Rochdale, and a loop line will serve Oldham, Stockport, Macclesfield, and Manchester. Another trunk line will serve Blackburn, Preston, and Clitheroe. A loop line [illegible] will serve Accrington, Burnley, and the Rossendale and Haslingden [illegible].

A trunk line passing south from the station will [illegible] St. Helens, Warrington, Runcorn, and Widnes, and a loop line will continue along the Ship Canal to serve the future industrial area of progressive Lancashire.

The author forecasted in the *Builder* 10 years ago, that once the canal was made, its banks would become the future area of new industrial developments, and with a line of power supply, a perfect railway connection, and a means of [illegible] it may be stated that no other area in the world would offer such facilities for cheap industrial production as this area with the [illegible] supply of cheap electric and unlimited energy proposed.

To realise the marvellous industrial fecundity of Lancashire and Yorkshire let us look at the diagram showing the proposed lines of electric power transmission as well as the state of the [illegible] system at present established. Here we have the nervous centres of industrial life before us at a glance, the very acme of economy in transmitting thought. Let us go a step further and assist Nature by laying down a nervous industrial system to [illegible] power, and the picture, with the Ship Canal complete, [illegible] and would be worthy of the enterprise of the counties of the Red and White Rose.

(To be continued.)

PHYSICAL SOCIETY.—November 25, 1892.

Prof. S. P. Thompson, D.Sc., F.R.S., vice-president, in the chair.

Messrs. T. J. Fry, A. G. Bessemer, jun., and E. F. [illegible] d'Albe were elected members.

The following communication was made: "**Experiments in Electric and Magnetic Fields Constant and Varying**," by Messrs. Rimington and Wythe Smith. In the first set of experiments shown, exhausted electrodeless tubes and bulbs were [illegible]

* "The Economics of Industrial Hygiene." The *Proceedings* of the International Congress of Hygiene, 1891.

rapidly in a constant electric field between two parallel-charged discs. Double fan-shaped images were produced by the tubes, due to the displacement currents which pass to equalise the potentials at the ends of the tubes. These fans were not symmetrical with respect to the lines of electric force, but were displaced in the direction of rotation. In explanation of this phenomenon it was pointed out that as a tube rotated the potential difference between its ends increased, until this difference was sufficient to break down the dielectric in the tube. The discharges would therefore pass at the ends of the intervals, during which the difference of potential was rising, and consequently the images would be displaced from the symmetrical position in the direction of rotation. The number of discharges produced during one revolution was found to depend on the strength of the electric field, but not on the speed of rotation, and that end of the tube which was approaching the negatively-charged plate appeared brightest. These experiments were referred to as examples of the direct conversion of mechanical energy into light. Instead of rotating tubes in a constant electric field, the tubes were next kept stationary, and a varying electric field produced by connecting the plates with an influence machine allowed to spark. Under these conditions the tubes and bulbs were seen to glow. Using large suspended plates charged by an induction coil, long tubes were caused to glow brightly even at considerable distances away from the plates. The glow could be apparently wiped out by passing the hand along the tube. Another series of experiments were performed in varying magnetic fields. With a view to showing Hertzian phenomena to large audiences, the authors tried Geissler tubes to replace the spark gap in resonators, with great success. When large Leyden jar circuits were used, the effects were very brilliant. Another form of resonator consisted of a bent wire terminating in two plates, between which an exhausted tube was placed. This tube became luminous when the resonator was placed in the vicinity of a fairly large Hertz oscillator. Other experiments, similar to those shown before the society by Prof. J. J. Thomson at Cambridge, on discharges in exhausted bulbs were then made, the bulbs being placed with a coil of wire of four turns forming the connection between the outer coating of two small jars, whilst sparks passed between knobs connected with the inner coatings. The bulbs glowed brightly at each discharge rings of light being seen near their inner surfaces. On putting a ring tube outside the coil, this was also seen to glow. The most brilliant part of the glow always occurred in close proximity to the wire coil. A secondary coil wound by the side of the above-mentioned primary could be short-circuited at will; this had the effect of decreasing or extinguishing the luminosity in the bulb or tube. Bright sparks passed between the secondary terminals when held a short distance apart, but the shock experienced by touching the ends was not serious. The above arrangement, with the addition of two Geissler tubes placed in series between the outer coatings of the jars, was used to illustrate the fact that closing the secondary diminishes the impedance of the primary circuit of a transformer. Experiments on condensers made of tinfoil or glass were shown. In one of them, parts of the coatings, in the form of letters, had been removed, and the spaces became luminous when the condenser was connected with an induction coil. In another experiment a glass plate was moved to and from a condenser, and a musical note could be heard whose pitch increased as the distance between the glass plates diminished. The note was said to be the octave of an open organ pipe whose length was equal to the distance between the plates.

CHELTENHAM.

[Four reports have been issued as to this lighting: (1) that of the committee, (2) preliminary by Prof. Ayrton, (3) final by Prof. Ayrton, and (4) by Mr. Hall. The final report of Prof. Ayrton we give herewith, reserving that of Mr. Hall for our next issue.—ED. *E. E.*]

The two main points to be decided on with reference to the electric lighting of Cheltenham are the system of distribution to be adopted, and the site to be selected for the central station. As intimated in my previous report, I am of opinion, for the following reasons, that a low-pressure system, radiating from a single generating station, could not economically be employed in supplying electric light to Cheltenham: 1. The private lighting, for some time to come, will probably be scattered. 2. The size of the area to be ultimately lighted is large; hence, a high-pressure system with some plan of transformation must be employed. If direct current be employed, the only methods of transformation must consist in using either accumulators or motor-dynamos. With accumulators, or storage cells, I have had much experience from about 1881, when I was appointed electrician to the Faure Electric Accumulator Company, on the first introduction of commercial accumulators into England. The experiments that I have from time to time carried out show that the methods of manufacturing accumulators have been steadily improved, and samples of one of the latest forms, which I tested this year, I found to be vastly superior to the earliest commercial specimens on which I experimented in 1881. But, in spite of these improvements, accumulators are inferior to motor-dynamos in all three particulars—prime cost, cost of maintenance, and efficiency when used to convert electric energy at high pressure into electric energy at low. These two systems of direct-current transformation have had a fair trial in the district allotted to the Chelsea Electricity Supply Company during the past three or four years, and, to an important extent in that district, accumulators have been replaced by motor-dynamos. A motor-dynamo, as its name implies, is a combination of a motor with a dynamo. The motor is constructed to be worked with a small current at high pressure, and drives a dynamo which is constructed to generate a large current at low pressure. Two commutators with two sets of brushes must be employed with the combination, and, if the plan of banked transformers be adopted (so that whatever power is required at any particular time the transformers in use at a sub-station are working at nearly full load, and, therefore, at nearly maximum efficiency) there would be several motor-dynamos—that is, several pairs of commutators and sets of brushes at each sub-station. Now, although it is possible for several motor-dynamos to run satisfactorily for several hours without being touched, no engineer would like to trust the lighting of a district to the running of high-speed machinery without supervision. Hence, if motor-dynamos be employed it would be necessary to have an attendant at each sub-station, or at any rate to arrange that attendants should pay frequent visits of inspection to the sub-stations. If, on the other hand, alternate current be used, the transformer becomes a stationary piece of apparatus consisting simply of two coils of insulated wire (one composed of a long thin wire and the other of a short thick wire), wrapped round pieces of laminated iron. The transformer requires, of course, no oiling nor trimming of brushes as with a motor-dynamo; further, the full pressure between the mains can be switched suddenly on to an alternate-current transformer, whereas with a motor-dynamo resistance coils must be employed and gradually withdrawn from the circuit to allow the pressure to increase slowly as the machine gets up speed. It is therefore not necessary for the person who desires to alter the number of alternate-current transformers in use at any time in a sub-station to enter the vault in which the transformers are banked; all that need be done is to turn a switch let into the surface of the road or pavement, just as a turncock turns on or off the water. The following calculation gives a fair notion of the difference in the first cost of plant (irrespectively of mains, buildings, etc.) for transforming 96 kilowatts, or the amount of power sufficient for about 1,450 incandescent lamps of 16 c.p., or for about 2,500 incandescent lamps of 8 c.p. Transforming by means of:

Accumulators (two sets being required)	£7,000
Motor-dynamos	800
Alternate-current transformers	330

The prime object of using transformers at all arises from the fact that the pressure that can be used in a house is limited by law, and by the present construction of the incandescent lamp, whereas the higher the pressure that is maintained between the supply mains the smaller is the current required to convey the power from the central station, hence the smaller may be the cross-section of the copper for a given percentage of loss of power arising from resistance. Now, whereas in consequence of the risk of flashing from one brush to the other across the commutator (about 1,000 volts is the maximum pressure for which motor-dynamos have been constructed), transformers for alternate currents are in use for 2,000, 5,000, and 10,000, and even a larger number of volts. Two thousand volts can, therefore, be used with alternate-current transformers without any risk of a breakdown, and the copper of the supply mains kept to half the cross-section that would be necessary if a pressure of only 1,000 volts were employed. Further, as regards the generating dynamo itself, there need be no commutator, and, indeed, there need be no moving parts at all at a high pressure if an alternate current be produced. This greatly facilitates the steady production of high pressure. Consequently there are several reasons in favour of employing alternate current. The main objection at the present day arises from alternate-current motors not having been brought to the same perfection as direct-current motors. I am inclined to think that this is but a temporary disadvantage, since the large amount of attention that is at present being directed to alternate-current machinery will in all probability lead to considerable improvement in alternate-current motors. But in any case, as the demand for motive power in Cheltenham will probably be small, the question of greater or less efficiency possessed by small direct and alternate current motors is comparatively unimportant compared with the main consideration regarding a cheap and efficient supply of electric light. Another objection that might be urged against the use of alternate current is that there is no method of storing power similar to that afforded by accumulators in the case of direct currents. In the early days of electric lighting the advantage of having a reserve of power that could be drawn on in the case of a breakdown of the electric machinery was invaluable, but with the improvements that have been introduced into the construction of dynamos, etc., and by the employment of several dynamos, and, if desired, of separate steam engines on the same central station, and by the steam-pipe being arranged so that the steam can enter at either end, the risk of a total breakdown has been rendered almost nil. Another advantage derived by the use of accumulators is that the boiler fires need not be kept up during the slack portion of the 24 hours, the electric power sent into the mains being then taken from that stored in the accumulators. But with a destructor, where refuse has to be burnt whether power be required or not, the importance of economising fuel and labour during the periods when electric light is required by the town is much smaller. And it is to be noticed that in a recent report which Dr. Oscar von Muller and Herr Baurath Lindley have made on the future electric lighting of Frankfort, they have strongly recommended the employment of alternate current, as they conclude that the advantages far more than counterbalance

the disadvantages. Further, the two companies—the Brush Electrical Engineering Corporation and Messrs. Laing, Wharton and Down—between whom the electric lighting of the City of London has been divided, have both adopted alternate currents for house and shop lighting. I am, therefore, of opinion that for the electric lighting of Cheltenham an alternate-current system should be employed, the power being sent along the supply mains from the generating station at a pressure of not less than 2,000 volts, and that for domestic and shop lighting the pressure should be reduced by banked transformers at sub-stations to not less than 110 volts. If 100-volt lamps were employed, the mains would require to have 10 per cent. greater cross-section than would be necessary with 110-volt lamps. The advantages of erecting the central generating station at the destructor, rather than at the central depot, are: (1) Power to the extent of about 70 h.p. day and night in the winter, and about 30 h.p. day and night in the summer, is available from the burning refuse. If it may be regarded that from this source an average of, say, 40 h.p. day and night throughout the year is available, then taking the price of coal at only 10s. per ton, and assuming that only 4lb. of coal need be burnt per hour to generate 1 h.p., the burning of the refuse instead of an equivalent amount of coal will represent a yearly saving of £313 on the coal bill. (2) Economy in labour and supervision, since two entirely separate staffs will not be required at the destructor and at the central station. (3) The saving of some £1,000 that would have to be spent in building a tall chimney at the central depot, if that site were selected for the generating station. (4) The nuisance from smoke issuing from the chimney outside the town would be comparatively small. (5) Land near the destructor can be obtained when required at a comparatively low price for an extension of the central station. The advantages of erecting the generating station at the central depot are: (1) About £900 would be saved in the cost of the cables and conduits required during the first year or so, and about £1,600 in cables and conduits during the first 10 years. (2) One shilling and sixpence per ton would be saved in the price of coal. As regards advantage No. 1 in favour of the central depot site, it is to be noticed that it is practically balanced by advantage No. 3 in favour of the destructor site. The practical importance of the second advantage—the saving of 1s. 6d. per ton of coal—depends, of course, on the total consumption of coal per year. If the yearly consumption were to be the same at one site as at the other, the diminished price of coal at the central depot would undoubtedly be an important advantage in its favour; but the 70 h.p. day and night during the winter, and the 30 h.p. day and night during the summer, developed by the burning of the refuse, will alone be enough for the day and the midnight electric lighting of the borough for some time to come. We have, therefore, to consider the extra cost per ton of coal burnt at the destructor, and compare it with the total cost of the extra amount of coal that would have to be burnt at the central depot. It is probable that for some time to come the average power required for the three busy hours of the evening will not exceed 100 h.p. throughout the year, or, in other words, that the extra power that will have to be developed at the destructor by the burning of coal will not exceed, and probably will be considerably less than, 60 h.p. for three hours per night. This, at 4lb. of coal per hour, represents an annual consumption of 117 tons of coal at the destructor, on which the extra cost would be £8. 15s. 6d., at 1s. 6d. per ton. But this extra cost is insignificant compared with the £313 per year saved on the coal bill by the burning of the refuse. Indeed, even when the time comes that 500 h.p. will be required for three hours per night on the average (corresponding with the supply of current to about 5,000 incandescent lamps of 16 c.p., or about 10,000 incandescent lamps of 8 c.p.), the extra cost of the coal burnt at the destructor will not amount to one quarter of the total saving arising from the burning of the refuse. Further, it must not be forgotten that the land at the central depot may in time become very valuable for business purposes, and therefore that it would be unwise to use it for an electric light station, which certainly need not be placed in the heart of the town. From a financial point of view, therefore, it seems quite certain that the destructor site, and not the central depot site, should be selected for the generating station. And even apart from these financial considerations, I could not advise the Corporation of a residential town like Cheltenham to erect what, at the best, is nothing more than a somewhat noisy factory with possibly smoking chimneys in the centre of one of the best districts. The preceding pages of this report were written before the 7th inst., when I received Mr. Hall's report, dated the 1st inst. This report of Mr. Hall's is a supplement to his previous one, necessitated by the Electric Light Committee having decided to adopt arc lamps rather than incandescent lamps for outdoor lighting (after seeing the experiments which I suggested should be carried out before a decision was arrived at). Placing arc lamps in the middle of the roadway in the Promenade would be most economical as regards light, but as centre pillars are out of the question from an artistic point of view, it would be necessary to resort to the ancient method of lighting streets—viz., to suspend the lamps by chains over the middle of the road. This would of course necessitate two iron pillars, one on each side of the roadway, for every arc lamp used, and as an arc lamp and lantern are somewhat heavy the pillars would have to be strong, and therefore would be somewhat costly, especially if ornamental. Further, since the main object of changing from gas to electric lighting in the Promenade is not because the present gas lighting is very inefficient, but in order to obtain a more picturesque and brilliant effect, the mere saving in electric power does not appear to me to be the main consideration in this particular instance. Now the effect of arc lights among trees covered with leaves is extremely pretty, and if the number of arc lamps (22) proposed by Mr. Hall were increased to 25 or 28, the lighting of the road and paths would be [illegible] number of lamps were used, and the lamps were placed on posts between the trees. I would therefore recommend that [illegible] of placing the lamps be carefully considered before a decision is arrived at. As regards the High-street and similar places, the method of slinging the lamps from chains suspended across the street and attached to the buildings on each side has many advantages. The chief disadvantage is the interference of the chains with the rapid transit of a fire escape, but, in a town like Cheltenham, which presumably has not a number of fire engine and escape stations, and, therefore, where escapes coming along the road to all parts of the town need not be anticipated, as in London, this difficulty might easily be overcome. I observe that Mr. Hall, in this supplemental report of November 1st, proposes that the excavation of the roads and the making of conduits, the fixing of the copper strip in the low-pressure districts, and the wiring of the arc lamp pillars, shall be done by Corporation workmen. The excavation and the building of the conduits might be well carried out in this way, but unless the Corporation can succeed in securing the services of really skilled jointers—a somewhat difficult task, as skilled workmen are already in the permanent employ of electrical contractors—there is great risk of the joints being faulty; and it has to be most carefully remembered that a joint which may be perfect from a purely mechanical point of view, may, in consequence of a [illegible] having been introduced in the [illegible], or in consequence of the insulation not having been properly carried out, be most defective from an electric point of view. The larger portion of the work Mr. Hall quite rightly proposes to have done by contract. The drawing up of the various specifications for the different parts of the work will have to be most carefully done, first so as to secure uniform excellence, and at the same time so as to allow each contractor to use the special apparatus and machinery which he is accustomed to employ, and so that the tenders may be properly compared with one another when received. Frequently, due to want of precision in the specification, tenders differing widely in amount are sent in by different firms for the same nominal piece of electrical work, whereas the highest tender may not be the dearest, as the particular firm submitting that tender may [illegible] include far more than, or intend to do the work in a [illegible] superior manner to, another firm submitting a much lower tender. For the first year's running Mr. Hall estimates that [illegible] tons of fuel will be required. This appears to me to be [illegible] high. For incandescent lamp lighting he estimates that [illegible] Board of Trade units will be required during the year, in addition to the maintenance of the 28 arc lamps. This latter I [illegible] will not consume more than some 6,500 Board of Trade units, so that a supply of some 74,000 Board of Trade units will be consumed during the first year. Mr. Hall estimates that 60 h.p. to 70 h.p. will be available at all times from the burning of the refuse; in this report I have estimated this at an average of 40 h.p. at all times, but taking Mr. Hall's figure of 60, then this will require to be increased by perhaps another 60 h.p. by the burning of coal during the four busy hours of the evening. The total number of Board of Trade units thus delivered during the four [illegible] evening hours alone amounting to about 70,000, or nearly the total estimated supply. But at 8lb. of coal per horse-power, which is a high rate of consumption for a condensing steam engine, this 60 h.p. for four hours per night throughout the whole year, only amounts to some 300 tons during the first year. Mr. Hall's much higher estimate of the first year's coal consumption is, however, a fault on the right side, since the demand for private and shop lighting may at first not be quite as large as is assumed in Mr. Hall's estimate, and therefore the first year's financial result will probably not be worse, and may perhaps be better than he estimates it. The introduction of electric lighting into shops and private houses is very much a matter of fashion. There are parts of London supplied by a public electric lighting company where rows of shops may be seen still lighted by gas, while at other spots may be seen a row of shops every one of which is fitted with the electric light. If, then, the fashion of using the electric light be judiciously set at Cheltenham, there is little fear that at the low price of 6d. a Board of Trade unit, and still more at the still lower price of 5d. a unit, the electric light will be generally adopted in the richer parts of the town. For it is to be noted that this latter price is lower than that charged in any part of London, the lowest price yet charged in the city being 6d. per Board of Trade unit for electric lighting in the St. Pancras district. It would be well when the time comes, by means of a lecture or by other suitable means, the public be taught that the nominal light given by a five-cubic-foot gas burner does not apply to ordinary ungoverned burners, but only to special forms not generally found in houses. And, therefore, that the cost of lighting with common house burners is much larger than might be imagined by using the nominal candle-power of gas burners. I do not think that any fear need be felt regarding improvements in electric machinery rendering obsolete in a few years the best apparatus of to-day. So much attention is now being directed to electric lighting that improvements are sure to be effected; but if the Corporation of Cheltenham can provide the inhabitants with a good light and earn a dividend for some years to come, it will be of little consequence that the machinery now to be bought can, when worn out, be replaced by better. A fair sum should, of course, be set aside for depreciation, and this has been done in the estimates I have just submitted to you. Whether this sum will ultimately be spent in purchasing machinery exactly like the original, or machinery possessing [illegible] improvement in no way affects the wisdom of now introducing the electric light.

NEW COMPANIES REGISTERED.

Hove Electric Lighting Company, Limited.—This Company has been formed, with a capital of £40,000 in £5 shares, for the purpose of taking over from the Commissioners of the town of Hove, Sussex, the undertaking comprised in the Hove Electric Lighting Order for 1890. The undertaking comprises the right of supplying electricity for public and private lighting and heating, and as a motive power, throughout the whole of the town. The prospectus states that nearly one-fourth of the capital has already been subscribed by the Directors and their friends. The Directors are: Colonel A. J. Filgate, R.E., 106, Jermyn-street, W.; Colonel H. Wood, C.B., 95, Thorpe-road, Norwich, vice-chairman; H. A. Hoare, Esq., The Hill, Hampstead, N.W.; Carleton F. Tufnell, Esq., A.M.I.C.E., Lloyds, London; John Wilkes, Esq. (managing director of John Wilkes, Son, and Mapplebeck, Limited, Birmingham). Consulting engineers: Messrs. Crompton and Co., Limited, Mansion House-buildings, London. Secretary: Francis R. Reeves, Esq., M.I.E.E., F.I.S. The offices of the Company are Mansion House-buildings, London, E.C., and 79, Western road, Hove, Sussex.

Scottish House-to-House Electricity Company. — The prospectus of this Company has been issued with a capital of £100,000 divided into 20,000 shares of £5 each, of which 19,900 are ordinary shares and 100 are founders' shares. The profits of each year are applicable first to the payment of a dividend at the rate of 7 per cent. per annum on the amount paid up upon the ordinary shares, and, subject to the memorandum and articles of association, one-half of the profits thereafter remaining belong to the holders of the ordinary shares, and the other half to the holders of the founders' shares. An issue of £30,000 in 6,000 ordinary shares of £5 each is now asked for, the lists closing on Monday, December 19. The Directors are: Peter McLagan, Esq., M.P., D.L., J.P., Calder Hall, Mid Calder, N.B.; John Hannay, Esq., Powton, Garlieston; George Flett, Esq. (Messrs. Dick, Kerr, and Co., Limited), London and Glasgow; W. D. Cairney, Esq., C.A., George-square, Glasgow; Timothy Bost, Esq., 33, Renfield-street, Glasgow. The consulting electrical engineer is W. A. Bryson, F.R.S.E., M.I.E.E., Glasgow. This Company holds a provisional order from the Board of Trade, confirmed by Act of Parliament, giving it the right of supplying electricity throughout the whole of the burgh of Coatbridge, a district, the prospectus states, eminently suited for the electric light in consequence of the large number of iron works and other industrial enterprises there carried on.

Walsall Electrical Company, Limited.—Registered by Frith Needham, 10, New-inn, Strand, W.C., with a capital of £10,000 in £10 shares. Object: to acquire as a going concern the business of a manufacturing electrician and electrical engineer, now carried on by Frederick Brown, Walsall, Stafford, and at Birmingham, under the style of the Walsall Electrical Company, in accordance with an agreement expressed to be made between Frederick Brown of the one part and this Company of the other part, and to develop and carry on the same. There shall not be less than three nor more than five directors. Qualification, £250. Remuneration, £1. 1s. each for each Board attendance, not to exceed 13 guineas each per annum.

COMPANIES' REPORTS.

THE ELECTRIC CONSTRUCTION CORPORATION, LIMITED.

Directors: Sir Daniel Cooper, Bart., G.C.M.G. (chairman), J. Irving Courtenay, Esq. (vice-chairman), Sir Henry C. Mance, C.I.E., George Dibley, Esq., Henry P. Holt, Esq., Joseph Moseley, Esq., James Pender, Esq., John B. Verity, Esq. Works Director and Chief Engineer: Thomas Parker, Esq., M.Inst.C.E., M.I.E.E.

Report of the Directors to be submitted to the shareholders at the ordinary general meeting, to be held at Cannon-street Hotel, E.C., on Friday, the 16th December, 1892, at 12 noon.

The Directors beg to report that, notwithstanding many unexpected difficulties which were encountered during the last 12 months, the result of the year's working shows a satisfactory balance to the credit of profit and loss account. The profit for the year is £46,693. 11s. 7d., after deducting the expenditure on plant, machinery, and patents, paying the interest on debentures and other loans, and placing a sum of £10,000 to a reserve for bad and doubtful debts. Including the balance of £10,721. 19s. 4d. from last year, there is a surplus to be dealt with of £57,415 10s. 11d. The amount of work executed during the last 12 months compares favourably with that of previous years. The contracts with the Liverpool Overhead Railway Company, Limited, and the South Staffordshire Tramways Company, have been nearly completed. The Liverpool overhead line is expected to be in full working order by the end of the year, and the Staffordshire electric tramway has already been passed by the inspector of the Board of Trade who has expressed himself thoroughly satisfied with the system employed and the work done by this Corporation. A very successful system has been carried out for lighting the city of Oxford, and the Directors have every reason to believe that these important works will serve to bring large additional contracts to the Corporation. During the past year valuable experiments have been carried out at the laboratory of the Corporation at Bushbury in connection with the present methods of producing zinc, chlorine, and alkalies. Mr. Parker considers the results which have been obtained highly encouraging, and a company has been formed for the purpose of commencing the manufacture on a commercial scale and to demonstrate the value of the patents. Of the preference shares offered for subscription 2,926 shares were taken up. The capital thus provided has not been sufficient for the purposes of the Corporation. With a view, therefore, to improve its general financial position the Directors have consulted the Electric and General Investment Company, Limited. That company has obtained a special report from the auditors, Messrs. Broads, Paterson, and Co., and has also caused an examination to be made of the works and plant at Wolverhampton by Messrs. Wheatley Kirk, Price, and Goulty, who have reported generally on the manufacturing business of the Corporation. As a result of obtaining these reports and of their own investigation of the affairs of the Corporation, the Electric and General Investment Company, Limited, has agreed to issue £100,000 additional capital for the further development of the business, and has guaranteed that the subscriptions shall not be less than one-half of the issue. Such additional capital to be raised by the issue at par of second mortgage debentures of £10 each, bearing interest at 6 per cent. per annum, and redeemable, at par, by half-yearly drawings over a period of about 15 years, and entitling the holder, by way of bonus, to an income bond of like amount, carrying interest as from the date of the redemption of the corresponding debenture at a rate for each year equal to the dividend declared on the ordinary shares for the preceding year. In order to secure for the shareholders the full benefit of this arrangement, the Directors have stipulated with the Electric and General Investment Company, Limited, that the whole of the debentures shall be allotted to the shareholders in proportion to their respective holdings, and a circular carrying out this arrangement is sent herewith. All allotments not taken up by the shareholders or their nominees on or before the 19th inst. will be cancelled. In accordance with the understanding arrived at with the Electric and General Investment Company, Limited, the Directors do not propose that any dividend be paid upon the ordinary shares for the past year, but they recommend that the dividend at the rate of 7 per cent. per annum be paid on the preference shares up to 30th September last; that £30,000 be placed to a suspense account, and that the balance of £26,862. 1s. 5d. be carried forward. Several retirements from the Board have taken place during the year, and, as arranged with the Electric and General Investment Company, Limited, the Right Hon. David Plunket, Q.C., M.P., 12, Mandeville-place, W., and Mr. James W. Barclay, 5, Clarendon-place, Hyde Park, W., have been elected directors and will take their seats after the general meeting. The directors who retire by rotation are Mr. James Pender and Mr. John B. Verity, who offer themselves for re-election. The Directors are determined during the ensuing year to give their special attention to effecting economies in the expenses of administration, and they rely upon the next account showing material retrenchments in this respect, and that no occasions will arise for the exceptional expenditure shown in the accounts for the past year. They are confident also that the additional capital proposed to be raised for the purpose of developing the manufacturing business will be the means of largely increasing the net profits. Messrs. Broads, Paterson, and Co., the auditors, retire, but offer themselves for re-election.

PROFIT AND LOSS ACCOUNT FROM OCT. 1, 1891, TO SEPT. 30, 1892.

Dr.				£	s.	d.
Expenses and cost of production during the year ended 30th September, 1892, at Wolverhampton, including engineering department and laboratory expenses				149,776	13	7
Head office expenses, including rents, salaries, income tax, Directors' fees, accountancy, printing, stationery, and stamp duty, etc.				7,870	3	1
Auditors' fee				105	0	0
Interest upon debentures and temporary loans				8,485	5	0
Advertising, law charges, and professional fees				2,856	6	3
Reserve against bad debts, etc.				10,000	0	0
Special expenses:						
Expenses of issues of debentures and preference shares	£7,764	12	2			
Allowances on contracts, etc	9,602	17	0			
Commission and exhibition expenses	9,935	0	11			
				27,302	10	1
Maintenance of and additions to machinery, furniture, etc	3,125	13	8			
Maintenance of patents and costs of defending same	3,241	2	4			
				6,366	16	0
Balance carried to balance-sheet				46,693	11	7
				£259,456	8	7

Cr.				£	s.	d.
Sales and work executed during the year ended September 30, 1892				175,276	2	2
Dividends, transfer fees, rents received, and miscellaneous receipts				11,066	14	11
Shares received and to be received for licenses granted, patents sold, and profits upon formation of subsidiary companies, at par	£123,113	11	6			
Less reserve, as per balance-sheet	50,000	0	0			
				73,113	11	6
				£239,456	8	7

BALANCE-SHEET, SEPT. 30, 1892.

	£	s.	d.	£	s.	d.
Capital authorised						
62,400 ordinary shares						
100 founders' shares						
12,500 preference shares						
75,000 of £10 each = £750,000 of which have been issued :						
40,900 ordinary shares of £10 each	409,000	0	0			
100 founders' shares of £10 each	1,000	0	0			
1,623 preference shares £10 each fully paid	16,230	0	0			
1,303 preference shares £10 each £7 paid	9,121	0	0			
	325,351	0	0			
Less calls in arrear	10,501	5	1			
				314,849	14	11
1,500 first mortgage debentures of £100 each, of which £1,253 have been issued and remainder deposited as security				125,300	0	0
Liabilities						
Trade accounts, law charges, etc	47,241	17	9			
Loans	29,625	0	0			
Interest accrued on debentures	1,493	17	11			
Directors	731	5	0			
Bills payable	34,894	8	4			
				113,989	9	0
Reserve as per last balance sheet	25,000	0	0			
Reserve for bad debts, etc	10,000	0	0			
	35,000	0	0			
Less difference between par value of shares sold and the amount realised	6,467	0	0			
				28,533	0	0
Profit and loss account						
Balance from last year	10,721	19	4			
Balance of profit and loss as above	46,693	11	7			
				57,415	10	11
Contingent liabilities : On pending contracts ; shares partly paid up, and bills receivable discounted, about £100,000						
				£840,087	14	10

	£	s.	d.	£	s.	d.
Purchase of the works, businesses, and patents of Elwell Parker, Limited, of Wolverhampton, and of the Electrical Power Storage Company, Limited, of London, patent rights, etc., according to last balance sheet (N.B. — Expenditure £3125 13s. 8d. during the year has been charged to profit and loss, in lieu of depreciation)				314,847	8	4
Shares in subsidiary companies at par, received on capital account, as per previous balance sheets				120,000	0	0
				£434,847	8	4
Other shares in subsidiary companies, at par	£146,545	0	6			
Ditto to be received, at par	95,000	0	0			
	241,545	0	6			
Less reserve	50,000	0	0			
				191,545	0	6
Debts due by subsidiary companies				37,572	3	4
Book debts				90,901	18	1
Stocks at Wolverhampton and Millwall				35,320	9	3
Cash and London and General Bank, Limited, in liquidation				3,115	15	9
Board of Trade deposit				2,500	0	0
Bills receivable in hand				11,501	14	7
Cash at bankers				12,827	5	0
				£840,087	14	10

BUSINESS NOTES.

Bridgend. – The Bridgend Local Board have decided to apply for a provisional order.

Halifax. It is practically decided to light the new hospital at Halifax with electric light.

Edinburgh. – A deputation has been appointed to visit towns provided with electric light.

Penarth. A committee has been appointed to go into the question of electric lighting at Penarth.

Roumania. Tenders are required by January 10, 1893, for the lighting of Turn Severin, Roumania.

Blackpool. The Corporation has granted an extra allowance of £30 to Mr. Hesketh, their electrical engineer.

Newport. The Newport County Council have agreed to ask Prof. Robinson to report upon the electric lighting.

Eastern Extension Telegraph. The Directors have declared a quarterly interim dividend of 2s. 6d. per share, payable on the 15th prox.

Shirley. At Shirley (Hants) Local Board, when the lighting came up for discussion, Mr. Olds expressed his desire to have the electric light.

Windsor. The town clerk has been instructed to take action against the Windsor Electric Light Company for breaking up the streets without authority.

Aston. The Aston Local Board are obtaining information to make up a complete report on the electric lighting question, Mr. Booker having the matter in hand.

Dover. At the last meeting of the Dover Town Council the electric lighting agreement was brought up and read, and the Mayor said the work would now go on.

Western and Brazilian Telegraph Company. – The receipts for the past week, after deducting 17 per cent. payable to the London Platino Brazilian Company, were £2,865.

Rothesay. The Rothesay Town Council have agreed to appoint a committee to confer with the Harbour Committee to enquire and report on the cost of electric lighting the harbour and esplanade.

Bolton. The final report of the sub-committee on electric lighting is to be given shortly. We understand it [illegible] low pressure within the compulsory area and high pressure outside.

Sutton Coldfield. The borough surveyor of Sutton Coldfield in his report says that he trusts during the next year to see the Town Hall lighted by electric light by means of the turbines at Powell's Pool.

Chiswick. The Chiswick Local Board have not yet settled their arrangements with Messrs. Bourne and Grant on the [illegible] of electric light, and it is highly probable that the Board will readvertise.

Popp Company. The Paris Compressed Air Company [illegible] appears, passed into the hands of MM. de Bramens [illegible] the first attending to the electrical and the latter the [illegible] departments.

Taunton. The enquiry on Taunton electric lighting [illegible] which was to have taken place on Tuesday, has been [illegible] (Friday). As the question has been much debated an [illegible] meeting is expected.

Portsmouth. The tenders for central station plant [illegible] Portsmouth must be sent in by January 5. Plans and [illegible] can now be obtained (two guineas deposit) on application to Mr. Alexander Hellard, town clerk, Portsmouth.

Accumulators. M. Philippart has, according to the *Intermédiaire*, again taken up the manufacture of the [illegible] Sellon Volckmar accumulators. M. Gadot has taken [illegible] manufacture the same accumulators at his factory in the [illegible] Tourquoink.

Hampstead. The Electric Lighting Committee of the Hampstead Vestry has recommended the Vestry to undertake the [illegible] of electric lighting in the parish, under the powers [illegible] obtained from the Board of Trade, and to borrow [illegible] necessary plant.

Sheffield. The Electric Light and Power Company have given notice to the Sheffield Highway Committee that they [illegible] lay underground mains in certain streets. The committee [illegible] mend that notice of disapproval be given in accordance with the company's order.

Edinburgh. The Lord Provost's Committee of the Edinburgh Town Council at their meeting last week, remitted to [illegible] committee to take steps for giving effect to the provisional order on electric lighting obtained last year, and to call in expert [illegible] to their assistance.

Welsh Board Schools. – At a meeting of the Llangeinor School Board at Blaengarw, on Wednesday, Mr. [illegible] was decided to have the Wyndham School, Nantymoel [illegible] electricity, and also to have the new school building at Tynewydd fitted up with an installation.

Bristol. At the meeting of the Town Council on Tuesday the report of the Electrical Committee stating that Messrs. W[illegible] and Rawson declined to carry on the [illegible] recommending that the tender of Messrs. Aben and [illegible] be accepted, was considered and adopted.

Sheffield. Mr. Johnson, writing in answer to a [illegible] states that powers have been obtained, a site [illegible] the pit's mouth, with plenty of condensing water. The engine and boiler houses are to be enlarged and rearranged, the [illegible] underground mains has been sanctioned, and work will be begun in January.

Eccles. – At the monthly meeting of the Eccles Town Council the town clerk placed before the members a proof of the [illegible] provisional order for electric lighting, providing for the [illegible] a limited area within two years. The town clerk's [illegible] the subject was ordered to be printed and a copy [illegible] each member.

Dundee. At a recent meeting of the Lighting Committee of the Dundee Police Commission, it was [illegible] for the illumination of the central portion of the High [illegible] electricity. It was reported that the new light [illegible] probably cost £110 as against £70 for lighting the same portion of the street with gas.

Edison-Swan Company. – This Company have opened depots in Liverpool, Birmingham, Newcastle, Leeds, Hull, Cardiff, [illegible] and Dundee, and are about to open similar depots in [illegible] towns of the United Kingdom, for the supply of lamps [illegible] wires, cables, etc. These depots have been opened for the convenience of the trade only.

Paisley.—The tenders for the lighting of Paisley having been before the Council, and Mr. Bryson, the engineer, having given his opinion thereon, it was agreed to correspond with the parliamentary agents with the view of obtaining an extension of time for carrying out the provisions of the order.

Great Eastern.—The Great Eastern Railway Company are going to borrow £250,000 for improvements, among which are £15,000 for electric lock and block working; and £30,000 for the electric lighting of Liverpool-street Station and Hotel, the Bishopsgate passenger and goods station, the Bethnal Green passenger station, and the Spitalfields goods station.

St. Louis Electric Railway.—It is announced authoritatively that the General Electric Company of America has no idea of backing the St. Louis electric railway scheme financially, though it would be glad to get the order. The railway companies' stock is, however, being taken up fast, and construction work and the purchase of sites for power stations are going on satisfactorily.

Electric Block System.—The Great Western Railway Company have established their improved electric block system at Menheniot. Under the superintendence of Inspector Scantlebury, the signal boxes, lights, and lines have been adopted to the new plan, able assistance having been given by Inspector Gatfield, of Teignmouth, and Mr. Collam, of the railway company's electric staff at Plymouth.

Clifton Rocks Signals.—The contract for the erection of the electric signals in connection with the Clifton Rocks Railway has been secured by Messrs. King, Mendham, and Co., Western Electrical Works, Bristol and London. The arrangements to be made include means for signalling from the lower end to the top, the number of passengers to be carried up the railway each journey, replying and starting signals, and telephones.

Stafford.—The report of the Stafford Electric Lighting Committee, recommending the Corporation to take active steps for the provision of electric light, was adopted at the last monthly meeting of the Town Council. The cost of an installation for 3,000 lamps is given at £20,000; it would require 2,000 lamps to make it pay, and there is reason to believe 1,500 would be taken from the start. The Corporation own the gas works.

Redruth.—The Redruth Electric Light Supply Company's application to the Local Board to lay wires has been granted. The proposed capital of the company will be £10,000, an admirable site has been arranged for, and provisional agreements have been come to with leading engineers for the supply of plant. The current will be supplied on the low-pressure three-wire system, with accumulators. The three directors making arrangements are Messrs. R. H. Michell, E. Tangye, and C. Tweedy.

Morecambe Electric Light and Power Company.—The second ordinary meeting of this Company was held at Morecambe on Tuesday, Mr. W. B. Hodgson presiding. A dividend of 5 per cent. was declared as the result of the first year's working. The retiring director, Mr. W. C. Farrar, and the auditor, Mr. Duff, of Halifax, were reappointed. Mr. Wm. Morgan having resigned, Mr. Twycross was elected director in his place, Mr. W. Holdingworth and Mr. Wm. Wilson being also added to the directorate.

Scarborough.—The shares forming the recent issue of capital of the Scarborough Electric Supply Company were allotted last week. Actual work will now be commenced at once but it is anticipated that the light will be turned on in June next, by which time it is expected there will be a considerable demand for current. The alternate-current system will be employed with 1,000 volts pressure on the high-tension mains. Mr. A. A. Campbell Swinton has been appointed managing director of the Company.

Brighton and Hove Electric Light Company.—This Company announces that it is prepared to receive applications for £7,500 first mortgage debentures at par, being the balance unissued of a total issue of £15,000 of such debentures. The debentures are of £100 each, carrying interest at the rate of 6 per cent. per annum, and are convertible into ordinary shares, at the option of the holder, at any time on one month's notice. The business of the Company was established in 1882, and the Company itself was incorporated in 1885.

Ipswich.—At the meeting of the Ipswich Lighting Committee a letter was received from the Board of Trade asking if the authority desired to make any observations on a letter which they sent to the Ipswich Electric Supply Company pointing out that the company had failed to satisfy the Board of Trade that they were in a position to discharge the duties and obligations of the Electric Lighting Order of 1891, or make the deposit required by sec. 7, and that they propose to revoke the order. It was resolved that the Authority had no observation to make.

Nottingham.—The Nottingham Corporation on Monday decided to undertake the electric lighting of the borough, dealing first with the central area, at a cost of £50,000. The site suggested, which was in a good part of the town, was objected to, as it would cost tens of thousands of pounds, and several other sites, one belonging to the Corporation, were proposed. Sir John Turney explained that although other sites might be cheaper, they would entail more expense by reason of distance from the centre of the town. The scheme as recommended in the report was adopted.

Appointments.—The following are extracts from the minutes of the London Electric Supply Corporation: "Major C. B. Waller was elected to a seat on the Board in place of Mr. Arthur F. Wade resigned, and it was resolved that the thanks of the Board be given to Major Waller for his services as manager and secretary to the Corporation during the past five years; also, in view of the faithful and able services of Mr. R. Stewart Bain to the Corporation, it was resolved that Mr. R. Stewart Bain be appointed secretary of the Corporation in combination with his present duties as accountant."

Birkenhead.—At the monthly meeting last week of the Birkenhead Town Council, the Finance Committee recommended that the chairman (Alderman Deakin), deputy chairman (Mr. Goetenhofer), and Messrs. Widmer, J. Laird, Bloor, and the Mayor, be appointed to negotiate with the representatives of the Brush Electrical Engineering Company, Limited, and any other company, body, or person in reference to the proposed transfer of the powers of the Corporation under the Birkenhead Electrical Lighting Provisional Order, 1890, and that they be authorised to obtain professional advice and assistance if necessary or desirable.

City Lighting.—The amendment moved by Mr. C. T. Harris at the last meeting of the Commission of Sewers asking that a report on the subject of the electric lighting of the City streets should be referred back for further information, was carried by 22 votes to 11. The primary objection Mr. Harris has to the proposal that the side streets should be lighted by incandescent lamps is that it is an extravagant mode of outdoor lighting, and will greatly increase the original cost of the scheme; and, in the absence of any definite information as to comparative cost, Mr. Harris contends that the Commissioners are not justified in proceeding with the work.

Compagnie Electro Mecanique.—The French company of J. J. Heilman and Cie. have lately united with several other influential firms or companies, and formed a new company under the title of "Compagnie Electro Mecanique," with a capital of 1,000,000f. The following are associated with the new company: For boilers, engines, dynamos, and cables, Weyher and Richemond, Menier, Belleville, Brown Boveri, Edison, Societe Generale des Telephones, J. J. Heilmann; electric tramways, Ch. Brown. The office is 30, Rue de Grammont, Paris. Installations for the distribution of power and lighting on the Brown system are being carried out in the towns of Reims, Le Mans, and Narbonne.

Elmore's Foreign and Colonial Patent Copper Depositing.—The accounts for the financial year of the Company ended December 31 last show a balance at that date of £132,263. The Directors, in their report, state that they cannot at this time recommend the payment of a dividend, but they hope to be able, in the course of 1893, to make a distribution to the priority shareholders, leaving a handsome amount in hand for distribution among the founders. At the present moment, taking the Company's assets at par value, and after setting aside £5 per share and a fourth of the balance of the priority shares, or an extra £2. 15s. per share, there remains an amount equal to £13 per share for the founders.

Partnership.—Messrs. Waller and Manville inform us that they are about to enter into partnership with Mr. Joseph Kincaid, M.I.C.E., and that in future their business will be carried on under the style of Kincaid, Waller and Manville. Our readers are well acquainted with Mr. Kincaid's name as an engineer of considerable eminence, and Messrs. Waller and Manville are to be congratulated on the advantage their clients will derive from their association with him. This arrangement will come into effect on January 1st, 1893, when the offices will be at Mr. Kincaid's present address, 11, Great George-street, London, S.W. (telephone No. 3,011, telegraphic address, "Kincaid, London."

Electric Tramways.—Mr. J. Clifton Robertson, the tramway engineer, in his report to the Plymouth Corporation, considers the use of electric traction. He alludes to the 300 street railways in America, aggregating 3,000 miles in length, successfully worked under nearly every known condition of gradient and climate. He advocates overhead wire construction, the cost for poles, wire, and connections not exceeding £500 per mile. An extract from this report urging the use of electricity, published by Messrs. Casey and Clay, solicitors, of 21, St. Andrew's-street, Dublin, is being circulated in the Pembroke, Blackrock, Kingstown, and Dalkey townships. A perspective view accompanying shows the proposed Dublin electric tramway in action.

Electric and General Investment Company, Limited.—This Company has been authorised by the Directors of the Electric Construction Corporation, Limited, to issue to the existing shareholders of the Corporation £100,000 in second mortgage debentures to bearer of £10 each in proportion to their respective holdings. The debentures, which carry interest at 6 per cent., rank next after the £150,000 of first mortgage debentures already existing. They are redeemable at par by half-yearly drawings extending over a period of about fifteen years, £10,000 being set aside annually for interest and redemption purposes; and the subscriber for each debenture will receive, by way of bonus, an income bond for a like amount carrying interest from the date of redemption of the corresponding debenture at a rate equal to the dividend declared on the ordinary shares for the preceding year.

Cost of Electric Light.—The *Scotsman* has a careful technical explanatory article on electric lighting, units, and measurement, going into the necessary knowledge required by a householder. "All things considered," says the writer, "it may be safe to say that for ordinary house lighting, electricity at 4½d. per unit costs about the same as gas at 3s. 6d. per 1,000 cubic feet. There is one connection in which electric lighting will be cheap at any price. Brilliant illumination seems nowadays to be an essential feature of all busy shops, and what with early darkness and late closing numerous gas jets so alter the condition of the air in many of them that an hour in the evening is more trying to the shop assistants than three hours in the morning. With electric incandescent lamps the heat will to some extent remain—in these days it is not amiss—but the air will not become converted into slow poison."

Catalogue of Art Fittings.—There are some pretty designs shown in a catalogue of fittings which we have received from the

Electrical Company of 122 and 124, Charing Cross-road. No. 2,608, a three-light pendant, is of quite noticeably satisfactory design for the centre of a hall or drawing room. A simpler form to be recommended consists of three flint glass pans or flexible cords, separated out by a light framework of hammered metal. A good selection of wrought-iron pendants is given for single lamps or for several, and a number of small brackets, both simple and highly wrought, give considerable scope for selection. Some handsome figure standards will be very suitable for artistic rooms. The Eastern lady, carrying her parrot, and holding aloft her torch electric light, is very effective. The scope for these kinds of standards is growing, and gives an admirable outlet for the designs of good artists in small bronzes and statuettes.

Crompton Electric Supply Company of Australia.—The third annual general meeting of the shareholders of the Crompton Electric Supply Company of Australia, Limited, will be held at the registered offices of the Company, Mansion House-buildings, in the City of London, on Monday, the 19th day of December inst., at 3 o'clock. This meeting is called in compliance with the articles of association, but as the Directors have not yet received the audited statement of accounts from Sydney to the 31st May last, the end of the Company's financial year, it will be impossible to lay them before the meeting, and therefore a resolution will be proposed adjourning the meeting to await the arrival of the accounts. Mr. W. Trotter, J.P., chairman of the Australian Committee of the Company, is at present in London, but is leaving again for Sydney at the end of the month. He will attend the above meeting and make a verbal report to the shareholders on the position and prospects of the Company.

Barnet.—At the last meeting of the Barnet Local Board the memorial to the Board of Trade asking for the necessary powers to carry out a scheme of electric lighting in the district was brought up to receive the seal of the Board. Mr. Schmidt took exception to clause 10, which is as follows: "To exempt the Board from the obligation to supply electricity for public or private purposes in such portion or portions of the said area of supply or under such conditions or circumstances as may be specified in the order." The clerk said the form was exactly as prescribed by the Board of Trade rules. Mr. Schmidt said the clause in question was not in the Act of Parliament. It seemed contrary to common sense to get a provisional order, and that then the Board should not be obliged to supply private or public customers under certain conditions. Mr. James said he looked upon the clause as one which would be called "a saving clause." Mr. Widdicomb moved, and Mr. Wynne seconded, that the seal of the Board should be affixed to the memorial. The motion was carried, Mr. Schmidt refraining from voting.

New Swindon.—"Dynamo," writing from Birmingham to the *Swindon Advertiser*, says: "I notice that your paper, together with the *Contract Journal* and other mediums of advertising, announce that the Swindon New Town Local Board invite tenders for the lighting by electricity of their district from January 1, 1893. Is it not possible there is some mistake here, and that the date 1893 should read 1894? If not, I am amazed at the ignorance displayed. Nine days is certainly short enough time to obtain all necessary details to enable firms to seriously tender, but this is nothing compared with 10 days in which the fortunate firm must buy land, lay out their depôt, build engine and boiler house, put down engine and dynamos (which are not usually kept in stock on shelves, like sugar and sides of bacon), fix lamps in, I believe, 20 miles of streets, and have the whole system working to satisfaction. The whole thing is a farce on the face of it, and if the date is correct, the only conclusion that can be come to is that the advertisement is not a serious one." We can hardly believe ourselves that the thing was meant seriously; it might, however, give a chance to "installations in a fortnight" engineers.

Wolverhampton.—The Lighting Committee presented a report at the last meeting of the Wolverhampton Town Council with regard to electric lighting. They stated that they had received 15 tenders, and the following six were selected for consideration: The Electric Construction Corporation, high pressure continuous currents, £28,614 10s.; ditto, alternating currents, £29,525; Messrs. Siemens Bros., £27,105 5s., and £29,345 5s.; Messrs. Crompton, high pressure alternating, £28,628 10s.; and the Brush Electrical Engineering Company (high pressure alternating), £31,229 10s. Taking into account the future working expense of the scheme, the committee decided in favour of the Electric Construction high pressure tender. In addition the committee suggested that Mr. W. H. Preece, F.R.S., be appointed engineer for the carrying out of the scheme at a remuneration of 5 per cent. upon the works included in the accepted tender, and that the Finance Committee be empowered to raise sufficient Corporation stock for the financial requirements of the enterprise. The report was accepted, but owing to the lateness of the hour when it came forward it was decided to discuss the matter at a meeting to be held on Monday.

What do Companies Supply?—A case was tried at the Ipswich County Court on Wednesday, before his Honour Hugh Barclay Wilson, Esq., involving a principle of electric light supply which may affect some companies. A customer was sued for a sum for renewal of lamps. The defendant said the bill he agreed to settle was for light, not renewals and so forth. The Judge expressed the opinion that the lamp was a necessary part of the apparatus for producing light. The representative of the supply company maintained their business was to supply "electricity, and not light." The Judge said it was clear that there was a misunderstanding—the company sold electricity while the customer ordered light. But the globes were as necessary to produce the light as the electricity. There was no analogy between gas and electric light, as gas would burn without a proper burner. The company replied that electric light could be produced by a simple [illegible] tion of the wires. His Honour: "But you don't suppose a [illegible] would stand holding them together?" The defendant said he had several renewals before the company charged him at all, and he took the light on the understanding he was not to pay for fittings. The company's representative said this was for exterior fittings only. The Judge decided for the defendant with costs, and in answer for leave to appeal on account of the principle involved, said he thought the appeal would not lie, as the company had given the customer to understand they would keep up the light.

Neuchatel.—We mentioned last week the competition opened for projects for transmission of power of the River [illegible] to Neuchatel. The generating station will be situated at [illegible] Clees, and the turbines will give 900 h.p. at minimum and 2 [illegible] at maximum. Tenders will be required for turbines, dynamos and mains. The following are the particulars of the water power: Head available, 56 metres; flow, maximum 5,000, mean [illegible], minimum 1,700 litres per second. Dynamos will be coupled to the turbines to supply (*a*) electric lighting for Neuchatel, [illegible] nine kilometres from the station at Pré aux Clees; (*b*) [illegible] of power in Neuchatel Serrières; (*c*) eventually of [illegible] lighting and power distribution along line of route, [illegible] other localities adjacent; (*d*) for electric tramways and [illegible]. Applications of current for (*a*) and (*b*) only are to be [illegible] at present, and particulars for these only will be at present [illegible]. A jury of the following gentlemen will make the award: [illegible] Hirsch, director of the observatory and president of the Water Power Commission at Neuchatel; Dr. H. F. Weber, professor [illegible] Zurich Polytechnic; G. Colombo, professor at Royal [illegible] Institute, Milan; Oscar von Miller, engineer, of [illegible]; and R. V. Picou, electrical engineer, of Paris. Prizes of 5,000f., [illegible] and 3,000f. (£200, £160, and £120) will be awarded for the [illegible] best schemes, which will remain the property of the [illegible] Neuchatel. These must be sent, with motto, by January [illegible]. Particulars and sketch plan can be obtained by application to "Direction des Travaux Publics, Neuchatel, Switzerland."

London Electric.—A distinct feeling of satisfaction is [illegible] electrical circles at the appointment of Mr. H. F. Lewis [illegible] the Western Telephone Company) as general manager to the London Electric Supply Corporation. Mr. Lewis, who did so much for working up the business of the telephone company, will evidently be the right man to work up and direct the [illegible] business of the London Electric, and that very much can be done in this direction everyone will admit. The company [illegible] lamps equal to over 50,000 lamps of 8 c.p. connected, and [illegible] has been going well for some time past. Complaints, of which mention has been made, on the score of price against other [illegible] panies, have induced several large consumers to revert to the [illegible] company, and, curiously enough, with the result at the [illegible] nominal price per unit of a reduction of some 20 or 25 per cent. in the total quarter's rent—at least, so the account reaches us from a trustworthy source. Some rearrangements have recently been carried out at Deptford, and a new engine and dynamo of the [illegible] venient size of 300 h.p. have been put in. The engine is of the triple expansion vertical type, by Messrs. Plenty and Co., of Newbury, and the dynamo is as before a Ferranti alternator. The two old sets from the Grosvenor, each of 625 h.p., have been also set to work for some time back at 2,400 volts, transforming up to 10,000 volts for transmission. These are besides the two large engines of 1,250 h.p. at 10,000 volts, which are now running satis[illegible] factorily. We do not expect that any very decided [illegible] will take place in the general arrangements of supply, nor will sub-station distribution be introduced to any extent at the present moment, but the new type of transformers are being [illegible] put in with considerable saving in loss from magnetising [illegible]. The company can supply double their present load without extension of machinery, and there is evidently plenty of scope for active pushing of the business.

Ashburton Technical Workshops.—Ashburton Technical Workshops, just completed, are an extension of the Ashburton Grammar School, wherein the students will receive practical instruction in analytical chemistry, engineering, and blacksmithing, carpentry, and joinery. The buildings have been specially designed to fulfil the requirements of the Devon County Council and the Science and Art Department, and consist of [illegible] laboratory 30ft. long by 17ft., which will be fitted up with all the latest conveniences and improvements for the thorough teaching of chemistry in all its branches, practical and theoretical, [illegible] ing some attention to electricity. There will be bench accommodation for 16 students, and each will have gas, water, [illegible] burner services, and pneumatic troughs. In a [illegible] is a capital fume closet for the escape of any noxious gases [illegible] during the experiments, the gases being conducted through a glazed flue into the furnace chimney. The laboratory is [illegible] and light, and ventilation has been amply provided for. The [illegible] of the windows, including those in the lantern light, are [illegible] hung and work easily by cords. In the engineering shop, [illegible] accommodation is provided for practical instruction in [illegible] and blacksmithing, there being a [illegible] forge [illegible] shop and a forge hearth to take [illegible] and assaying on the other side, both flues being [illegible] the furnace chimney. The carpenters' shop [illegible] room, well lighted, and well ventilated, and benches will be provided for 16 students. The buildings have been erected to the entire satisfaction of the grammar school governors by Mr. [illegible] Stevens, contractor, of Ashburton, from plans drawn in competition, and which were prepared by his assistant, Mr. Fred [illegible], who has superintended the execution of the work. The [illegible]

County Council deserve credit for the thorough way in which they appear to be attacking the question.

Glasgow Tramways.—The following letter in advocacy of the cable system of traction from a correspondent signing himself "Well-Wisher," appears in the *Glasgow Herald*: 'Sir,—I am sure the ratepayers must feel grateful to you for the trouble you have taken in collecting all the available information as to the comparative merits of the different mechanical systems now operating the tramways of this and other countries. Your general finding in the matter seems to be that you advise that the cable system should be adopted on all the routes where the traffic is of a heavy nature, and that the overhead wire electric system should be introduced where the traffic is under a certain figure. The Tramway Trust may, however, fall into serious error if they base their decisions rigidly upon this principle, without considering other modifying local conditions. It must be remembered that the cable system was first introduced in the streets of San Francisco not for the purpose of overtaking heavy traffic, but to operate the cars over its steep tramway routes. In working cars on a tramway line with heavy inclines there must be a certain additional power expended over and above that necessary to propel similar cars on a level route, and in considering whether the traffic is or is not above a certain standard the extra power required to operate the cars alone must necessarily be added before the actual requirements of the particular route can be ascertained. Thus the Springburn tramway route, over which there is at present an eight-minute service of cars, although recognised as a good paying line, is perhaps the most expensive route to work in the city on account of its heavy gradients, and this point should be well considered before determining how it is to be worked in the future. I have very little faith in the electric system, as yet developed, for working heavy traffic, or for operating moderate traffic over heavy inclines; and I therefore think our Tramway Trust would act prudently in adopting the cable system for the Springburn tramway route." With reference to which we may point out that sufficient examples already exist of electric traction on heavy inclines in the United States for there to be any absolute need to leave electricity out of the question in this case.

Clapham to Paddington.—The Joint Select Committee appointed this year to join with a Committee of the House of Lords to consider the subway railway schemes within the limits of the metropolis were "convinced that direct communication through London for the main railway lines north and south of the Thames, whether for the convenience of their country or their suburban passenger traffic, would be of undeniable utility to relieve the overgrown passenger traffic along the chief thoroughfares, to provide for the natural expansion of London, and to check the congestion of our metropolitan population, by means, as Mr. R. M. Beachcroft in his evidence before the committee described, 'to facilitate a transference of the population out into the suburbs,' and to control and regulate workmen's trains in the public interests." The proposed railways, which the committee's report dealt with, were confined in their objects to meet the wants of the City and Charing Cross centres, but did nothing to provide for the north and south communications of West London. A scheme is, therefore, now on foot to promote a Bill in Parliament to provide direct and rapid means of transit between Paddington, the terminus of the Great Western Railway, and the great populations therein and north of the same, and South Kensington, Brompton, Chelsea, Battersea, Wandsworth, Clapham, and the districts which already have railway communication with Clapham Junction, the point where the L. and S. W. R. and L. B. and S. C. R. enter London. The report of the committee is to the effect "that the evidence submitted to them was conclusively in favour of the sufficiency and special adaptability of electricity as a motive power," and "that the methods of cable traction appear also to be of recognised utility," thus proving that the use of steam locomotives, while being impracticable in deep subways, is entirely unnecessary. The proposed line will follow, by means of a deep tunnel, on Mr. Greathead's well-known system, a route which lies very nearly due north and south, and will have intermediate stations at or about Uxbridge-road, Kensington-road, Cromwell-road, Old Brompton road, Fulham-road, King's-road, Cheyne-walk, Battersea Park, Battersea-road, Wandsworth-road, Clapham-road. It will also have covered means of access to various important centres.

Leith.—At the monthly meeting of the Leith Dock Commission, the minutes of the Works Committee showed that the question of having an installation of the electric light in the docks had been considered. The committee, while not prepared to recommend an introduction of the whole system, were of opinion that it should be introduced at or near the Victoria Dock; that to that extent it be remitted to the committee with full powers to carry out; and that meantime the superintendent be directed to consider the details of the work with a view to reporting thereon. Mr. Currie said the committee saw, with the present unfinished condition of the works on the east side of the harbour, the difficulty of making arrangements for a complete system of light on that side, and that there was also the further question as to whether the best site for the installation necessary for that side of the harbour would not be on part of the ground which was proposed to be reclaimed. They thought it would be inexpedient to attempt to deal with it until, at least, plans were further advanced with respect to the new dock. They saw no such difficulty with regard to the west side of the harbour, where the installation would be of a less extensive and costly character, inasmuch as the space to be lighted was very much smaller. It had also the advantage of being part of their works where a large amount of work was done—in fact, a larger amount of revenue was derived there than at any corresponding space under their jurisdiction. They therefore came to the conclusion that it would be of advantage to initiate the system on the west side of the harbour, and they would have the advantage of any experience. The committee had no intention of hurrying on with the work with any view of getting it done during the present winter. They thought it would be expedient to make all the arrangements for carrying it out during the summer, so as to be in readiness for the winter's work. They would also have the benefit of the action of the Edinburgh Corporation on the matter of electric lighting. In the course of his subsequent remarks, Mr. Currie mentioned that the total cost of the whole work was estimated at £8,000, but the cost of the portion proposed to be at once introduced would probably be between £2,000 and £3,000. The minute was approved, Mr. Currie explaining that two installations were to be made—one on the east side and one on the west side.

York.—The electric lighting at the York Courts of Justice was successfully inaugurated on Thursday, the 8th inst. The City Council or their engineer, Mr. Creer, were wise in having the new courts wired for the electric light instead of fixing up gas fittings. It is proposed eventually to take the supply of current from the mains of the city supply, but as the scheme is not yet completed a temporary plant has been provided and fixed in the basement corridor of the building. We have already mentioned this installation, but the following fuller details will be interesting. The corridor has been partitioned off, so that a very pleasant little machine-room has been made. The plant consists of a Crossley 18 i.h.p. gas engine and a Crompton dynamo capable of supplying current for 220 16-c.p. lamps. A temporary switchboard, with instruments, cut-outs, switches, etc., has been fitted up, and neat iron rods on uprights have been fixed round machine and engine. Altogether, for a temporary job, it looks very well, and has the appearance of having been carefully carried out. The building is wired and fittings in for over 500 lights, but for the present only 200 or 220 will be required at any one time. The principal switchboard is in the porter's office, and from this the current is distributed through the main circuits, the ground floor, with the courts, the first floor, the fire brigade department, and police quarters being the principal. Each of these circuits are subdivided into the usual smaller circuits. A five-light electrolier adorns the entrance hall, and the main corridor is served by three light electroliers. Three-light clusters under white glass shades are hung with silk flexibles in the sessions court and police court, and movable standard lamps are provided for the judicial benches. The clock tower contains 24 16-c.p. lamps. Lanterns on brackets are provided outside the main entrance to the courts, each containing three 16-c.p. lamps; the glass in lanterns might with advantage be a little clearer. The entrance to the police and fire brigade quarters are also provided with similar lamps. The drill yard is well lighted, and the police cells are each provided with a lamp having a reflector, giving a good light through the thick glass window into the cell. The wiring and the fittings of the building have been carried out by Messrs. Benham and Sons, of London, to the specification of Mr. Sydney Hargreaves, and the machinery by Messrs. Crompton and Co., under the supervision of Mr. B. H. Jenkinson. Mr. Creer, the city surveyor, deserves complimenting on the successful results of his labours.

Southport.—Colonel John Ord Hasted, R.E., Local Government Board inspector, held an enquiry at the Southport Town Hall on the 8th inst. respecting an application of the Corporation to borrow £28,000 for works of electric lighting. The town clerk (Mr. J. Davies Williams) supported the application, and among those present were the Mayor (Councillor Hulme), Alderman Griffiths, Alderman Hacking (chairman of the Electric Light and Gas Committee), Councillors Travis, R. Watson, Hesford, and several of the corporate officials. The town clerk stated the application was for the purpose of enabling the Corporation of Southport to carry out upon a progressive basis a provisional order which was granted to it in 1891. The area which was included in that provisional order was of an exceedingly limited extent, and when the matter was taken in hand it was seen that to comply with that which was compulsorily imposed upon the Corporation would not be a wise policy, so that the Electric Lighting Committee in formulating a scheme took into consideration the present and the near future requirements of the town. The plant proposed to be laid down would be sufficient to cope with a demand up to 6,600 16-c.p. lamps, provided first with certain additional engines and boilers in a building and additional distribution of mains laid in the town. Were they to confine themselves only to the present requirements of lighting they would only want 1,200 16-c.p. lamps, and there would be little saving in the items which make the expenditure in respect of the 6,600 greater than there would be for 2,000 only. Unless provision was made to meet the increasing demand which they anticipated, they could not expect the electric light to be properly appreciated in the locality. If they confined themselves to 2,000 16-candle light power, they contended that it would be unsuccessful from a financial point of view, because they were justified in expecting a large demand for the electric light from the large number of the population who resided in high-class houses. The method they proposed to adopt was to have the site of installation a considerable distance out of the town on account of the nuisance which might arise—viz., on the gas estate at Blowick. As to the question of mains, it was intended to take down two high-tension trunk mains, one in the direction of the business part of the town and the other in the direction of the residential part. The system to be adopted was not yet decided upon. The Local Government Board had given them permission to adopt either the alternating or the continuous

high current system, and he thought the latter would be decided upon if the transfer of the land could be acquired. Alderman Harking then gave evidence and stated that there had been 400 applications received for the supply of electric light from different institutions and business places in the town. It was probable that the principal streets would be lighted by the system. After further evidence the enquiry was concluded, there being no opposition.

Glasgow.—The central electric station which the Glasgow Corporation have in hand is rapidly approaching completion, and it is believed that the current will be ready to be supplied to private customers by Christmas. The station at Waterloo-street has been ready for some time, and the machinery is in a forward state, though all the engines are not yet erected. The station is a handsome building with a frontage over 90ft. in length and three storeys in height. The engine room occupies nearly the whole width of the site on the ground floor. The boiler house extends backwards from it at right angles at the west end—making an L-shaped erection—and above it is the accumulator room, where the storage cells are placed. Plant has been put in at first sufficient to supply 12,000 8 c.p. incandescent lamps, but the site contains space for appliances for 40,000 8 c.p. lamps. At present there are in the boiler house five steel boilers of the marine type 10ft. in diameter and 12ft. in length, having a working pressure of 160lb. to the square inch. These supply steam to seven Willans central valve compound engines, two of these being of 80 h.p., two of 150 h.p., and three of 250 h.p. These are to drive direct seven dynamos, continuous current, simple shunt wound. Two of them have an output of 400 amperes at 120 volts, two an output of 400 amperes at 230 volts, and three an output of 670 amperes at 230 volts. The buildings are very substantially constructed. The main walls are of stone, the division walls of brick, and the floors of concrete on iron girders, while iron is employed for the support of the roofs. The apartment measures upwards of 72ft. in length by 32ft. 10in. in width. The engines and dynamos are situated somewhat below the level of the street, and the switch gallery is at one end of the room. A powerful travelling crane, stretching over the engines at a considerable elevation, will make it possible to handle the machinery with great ease. The battery room, which is 49ft. by 29ft., contains two complete batteries, each of 57 cells, one for the positive and the other for the negative side of the current. The upper floors of the main building have not yet been subdivided, but it is understood that they will be used for office purposes and the storage of materials. The system of distribution adopted is the three-wire system at 200 volts. The five feeder mains leave the generating station. The mains consist, as now usual with this system, of copper strips 1in. by ⅛in. or ¼in. wide, carried in cast-iron culverts, formed in sections 4ft. 6in. long. They are 22in. in width and 6in. deep. The conductors are supported in the culverts on a series of porcelain bridges or insulators placed at a distance of 4ft. 6in. from each other, and arranged so as to carry the strips of copper ribbon without contact. Two porcelain tiles equally spaced are placed between the insulators to prevent the copper conductors, should they sag, from touching the iron and making contact with earth. To avoid possible danger from water leakage the culverts are protected by arched cast-iron covers, to which they are closely jointed by means of red lead putty. The sections are attached to each other with bolts and spigot and faucet joints, thus making the culverts water-tight from end to end. Any moisture finding its way in, either as the result of drainage or condensation, will run down to manholes, which are placed at intervals of 60 yards, and at the corners of each street, and will be pumped out if necessary. Where an abnormal amount of water can collect, a connection will be made with the city drains. The conductors have been made sufficient to meet all present requirements, but in the event of an increase of size being called for more copper strips can be run in without disturbing the pavements. Bare copper conductors have been laid wherever practicable. In the course of carrying out the work, however, it has been found that there are a great many more cellars below the pavement than were anticipated, and the conductors in many cases had to be laid in the roadway. The conductors here used are insulated cables carried in cast-iron pipes, as the culverts would have had to be put at an inconvenient depth in order to sustain the heavy traffic of the streets. The feeders consist partly of heavy copper strip in culverts and partly of Siemens armoured cables laid in wood troughing in the earth. Four miles of culvert have already been laid, while cables in pipes make three more miles of conductor. The copper used already amounts to 30 tons, and as much more will be required before the network at present proposed is complete. The streets which are to first receive the light will take a total of 106 arc lamps, placed on cast-iron columns at a height of 18½ft. above the level of the pavement. The cast-iron pipes to be used for the street lighting mains have been laid alongside the private supply mains, but the streets are expected to be lighted after the private customers have been turned on.

PROVISIONAL PATENTS, 1892.

DECEMBER 5.

22261. **Improvements in electric arc lamps.** Arnold Frank Hills, 6, Bream's buildings, Chancery lane, London.

22271. **Improvements in and connected with carbons for electric arc lamps.** Charles Walter Hazeltine, Norfolk House, Norfolk street, Strand, London. (Date applied for under Patents Act, 1883, Sec. 103, May 6th, 1892, being date of application in United States.)

22274. **A new or improved shade or screen for electric and other lights.** Edwin William Streeter, 76, Chancery lane, London.

DECEMBER 6.

22285. **An improvement in microphone transmitters.** George Lee Anders and Walther Kottgen, 10, Jeffreys-square, St. Mary's axe, London.

22308. **Improvement in incandescent electric lamps.** Eugene Walter Applegate, 321, High Holborn, London. (Complete specification.)

22333. **Improvements in ammeters and voltmeters.** Emil Hartmann, 21, Finsbury pavement, London.

22344. **Improvements in galvanic batteries.** William Walter and Frank Richard Wilkins, 128, Colmore row, Birmingham.

22346. **Improvements in telephonic switching apparatus.** [illegible] Davis Miller, 62, St. Vincent street, Glasgow.

22375. **Improvements in the method of welding or working metals electrically.** William Phillips Thompson, 6, Lord street, Liverpool. (Charles L. Coffin, United States.) (Complete specification.)

DECEMBER 7.

22422. **An improved automatic electrical call apparatus principally for use in telephone circuits.** Nat Kh[illegible], [illegible] Wilson street, Derby.

22473. **Improvements in dynamo electric machines.** Charles Eugen Lancelot Brown, 46, Lincoln's inn fields, London.

DECEMBER 8.

22534. **Improvements in musical instruments operated by electricity.** Paris Eugene Singer, 6, Victoria road, Kensington, London.

22589. **Improvements in electric switches.** William M[illegible] Mordey, 46, Lincoln's inn fields, London.

DECEMBER 9.

22615. **Improvements in electric current meters.** Michael Dr[illegible] Field, 96, Buchanan street, Glasgow.

22639. **Improvements in glass vessels for accumulators.** [illegible] Kroeker, 433, Strand, London. (Complete specification.)

22657. **A new or improved electric accumulator.** James [illegible] Lorrain, Norfolk House, Norfolk street, Strand, London. (Marius Dumont, France.)

DECEMBER 10.

22690. **Improvements in musical instruments actuated by electricity.** Paris Eugene Singer, 6, Victoria road, Kensington, London.

22719. **Improvements in street boxes used in the underground distribution of electricity.** William Geipel, 112, Belvedere road, Lambeth.

SPECIFICATIONS PUBLISHED.

1890.

14181. **Electrical fog signals.** Andrews. (Second edition.)

1891.

20413. **Electrolytic apparatus for making caustic soda, etc.** Bamberg.

22255. **Electric telephone transmitters.** Swinton.

22265. **Telephony and telegraphy.** Stephen and Davis.

1892.

1096. **Electric signalling on trains.** Shiels.

1024. **Electric switch.** Crompton.

5654. **Dynamo-electric machines.** Reignier.

8493. **Telephone transmitter.** Whitehead.

14785. **Electric despatch system.** Bryson.

15000. **Electrical circuits and cables.** Newton. Barrett.

16794. **Signal telegraphy.** Roughton.

17224. **Electrically heating and working metal.** Thompson. Coffin.

18116. **Electric arc lamps.** Mathiesen.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid	Price [illegible]
Brush Co.	—	[illegible]
Pref.	—	[illegible]
City of London	[illegible]	[illegible]
Electric Construction	[illegible]	[illegible]
Gatti's	[illegible]	[illegible]
House-to-House	5	[illegible]
India Rubber, Gutta Percha & Telegraph Co.	10	[illegible]
Liverpool Electric Supply	5	[illegible]
	3	[illegible]
London Electric Supply	[illegible]	[illegible]
Metropolitan Electric Supply	[illegible]	[illegible]
National Telephone	[illegible]	[illegible]
St. James	—	[illegible]
Swan United	[illegible]	[illegible]
Westminster Electric	—	[illegible]

NOTES.

Burnley.—Tenders are wanted for fitting the Burnley Town Hall with electric light.

Electric Heaters are being tried experimentally on several electric street railroads in New England.

London World's Fair.—A World's Fair for London in 1895 is proposed, and an executive has been appointed.

Turbines.—A double turbine, with compensated pivot, by Messrs. Escher, Wyss, and Co., of Zurich, is described and illustrated in the *Revue Industrielle* (December 10).

An Electrical Minister.—It is rumoured that Mr. Henry Villard, whose name is identified in America with electric traction interests, is to be appointed United States Minister to the Court of Berlin.

Chicago Catalogue.—The Royal Commission for the Chicago Exhibition are arranging for a series of introductions to the sections of the catalogue of the British section. That on "Electricity" will be by Mr. W. H. Preece, F.R.S.

Children's Lectures.—Electricity and its marvels will be the theme of Prof. Lodge's four addresses, to be given with experiments on four successive days next week, beginning on Tuesday, at the University College, Liverpool.

Popular Electrical Science.—The *Scotsman* is setting a worthy example to the large provincial dailies in giving a series of admirable articles, by an experienced hand, on "Electric Lighting." The second of these, on "Distribution," appeared in last Saturday's issue.

The Liverpool Overhead Railway.—The Marquis of Salisbury has accepted the invitation of the directors to open the overhead railway on Saturday, February 4. His lordship will arrive in Liverpool on the previous day, and will be the guest of the chairman, Sir William B. Forwood, at Blundellsands.

Technical Index.—We have received the "Fortschritte der Elektrotechnik" for 1891, second part, from Mr. Julius Springer, Berlin. This technical index to the advances in electrical science contains a classified list of articles in the journals, and a well-arranged set of paragraphs giving the salient points of progress of the past year.

Electric Lighting and Heating. — *L'Industrie Electrique*, No. 23, gives an elaborate description, with plans and sections, of the Grouvelle method of lighting and heating a private house from the same boiler plant. The arrangement seems very well thought out, and would be a useful one to adopt in many country houses.

Lecture on Edison.—A popular lecture was delivered last week at Leicester before the Debating Society and People's Institute on "Edison and his Inventions," by Mr. J. T. Gent. The lecture was well illustrated by limelight views. Mr. J. H. Parsons, who had charge of the lantern, also exhibited a miniature electric light installation.

Rubber.—The dearth of indiarubber has suggested to carriage builders who use rubber for their tires that a substance elastic, but not necessarily non-conducting, would do equally well for carriages, and leave more raw material for electrical and other purposes. The invention of such an artificial rubber should, therefore, prove profitable.

Western Electric Company.—This company sends us a handsome calendar, the principal feature, however, of which, is an excellent photograph of their exhibits at the late exhibition at the Crystal Palace. This is one of the best photographs of any exhibit we have ever seen, and as our readers know, we looked upon this exhibit as one of the best, if not the best, telephonic exhibit at the Palace.

Text-Books.—A second edition of the very comprehensive "Handbuch der Elektrotechnik," by Dr. Erasmus Kittler, has just appeared from the publishing house of Ferdinand Enk, of Stuttgart. The work is to be complete in three volumes, price 40 marks, with 675 woodcuts in the text. The same firm issues shortly a students' text-book by Dr. J. G. Wallenstein, 253 illustrations, price 12 marks.

Dublin.—The Irish capital is not behind in electric traction, and the jaunting car must give way to the trolley car. So, at least, the signs seem to point out, for the Dublin Southern District Tramway Company are applying for powers to use electricity on their lines to vary the present system. These lines they intend to double, using electric cars, as well as building new lines. The City Fathers meet to consider this important question on January 16.

Acid Measurement.—MM. Colette and Demichel, in the Exposition d'Alcool, in the Champs de Mars, Paris, showed a useful instrument for measuring electrically the exact degree of acidity of any solution. Two plates are placed in a trough, through which the acidulated malt is passed, connected to a delicate ampere-meter, and the readings on this instrument are a correct indication of the state of acidity. An alarm bell is arranged to ring at either of the extreme allowable limits.

Rotary Fields.—M. E. Yorel, in *L'Electricien* for 17th inst., has a mathematical study of a rotary field created by a continuous current. Signor Ricardo Arno, of the Lincei Academy, has an article on rotary static fields, reproduced in the same number. He has experimented with cylinders of mica, ebonite, and other materials, and has produced a electrostatic rotary-field motor of 40 grammes weight, working with 3,800 volts at a frequency of 40, the motor rotating at 250 revolutions a minute.

Railway Telephones.—On one of the American railways, that between Port Defiance and Edison, telephonic communication is arranged to prevent delays in case of accident. Along the line a telephone wire is strung, and there are special poles, down which wires run to the height of a man above the ground. Each car carries a telephone, and in case of accident communication can be established at once with the main office, and in case of trouble details can be telephoned, and instructions for running the trains on either side can be given.

Ball Lightning.—The captain of the German steamer "Flandria" reports a curious instance of lightning on March 6, 1892, in latitude 38deg. north and longitude 41deg. west. In the midst of a violent tempest a luminous ball, like a huge star, appeared in the midst of the blackened clouds, grew to a maximum, and then burst, followed by long rolls of thunder. Flashes of lightning spread in every direction, giving an intense light that blinded everyone for some minutes. This phenomenon was observed twice, the duration being about five seconds.

Electro-Culture. — Considerable interest is being aroused in scientific circles in this city, says the *Bristol Times*, in a lecture which Dr. E. H. Cook is to deliver on the above subject on Monday next, in the lecture theatre of the museum. Dr. Cook has been experimenting for several years in this field, and, besides giving a history of what is at present known on the subject, will describe and illustrate some of his own experiments. These have not been hitherto published. The lecture is under the auspices of the Literary and Philosophical Club, 28, Berkeley-square.

Car Fenders.—The question of fenders, or safety guards, for electric cars is exercising the minds of the tramway engineers and city authorities of Boston, U.S., to a very active degree. Several fatal accidents to children

caused the authorities to insist on the use of more effective guards, and the company offered to put on any that the city council recommended. This has thrown the responsibility on the city, and a committee are still considering the question. Meanwhile, the West End Railway Company themselves are doing their best to discover an absolutely safe guard.

Institution of Mining and Metallurgy.—The third ordinary meeting of the second session of this institution was held on the evening of Wednesday, December 21, in the lecture theatre of the Geological Museum, Jermyn-street, S.W. (the use of which was kindly granted by the Lords of the Committee of Council on Education). A discussion took place on the paper by Mr. A. G. Charleton, A.R.S.M., M.Amer.Inst.M.E., etc. (member), on "The Industry of Mining," read on November 16; and a paper was read by Mr. C. G. Warnford Lock (hon. treasurer) on "Gold Amalgamation."

Alternating-Current Motors.—A cheap, practicable alternating current motor, of one or more horse-power, capable of starting and stopping at once under full load, is the desideratum for electrical engineers dealing with alternate currents. This motor has at last, we are assured, been successfully brought to perfection by an English manufacturer, and will be put on the market in the early part of the New Year. The results have been most satisfactory, and the professors will shortly have their turn in being able to theorise to their hearts' content on the action of the motor, and, more to the purpose, the companies will be able to utilise their day load by selling alternating current for motive power.

Steam Power from House Dust.—Our attention has been drawn by the Refuse Disposal Company, Salopian Wharf, Chelsea, who have lately published a pamphlet on the question, to the practical means by which the dust refuse of towns can be utilised for electric lighting purposes. The question has been greatly before the minds of electrical and borough engineers, and they might do well to obtain this publication dealing with an important municipal subject. The company claim that 20,000 tons of house dust, if treated as they suggest, and burnt in suitable boilers instead of destructors, might be made to produce as much as 5,600,000 indicated horse-power hours, equal to an engine of 1,183 i.h.p. working for 4,734 hours, for electric lighting.

Testing Insulation at Work.—With every well-regulated installation a voltmeter and ammeter are provided, conveniently fixed on the switchboard, to act as gauges for the electrical energy. For thorough safety we require as well an equally convenient means of testing the insulation of the installation at work, and this in any part—mains, dynamos, transformers—as easily as now any pressure can be tested on the voltmeter. The French Society for Encouragement of Sciences offers a prize of 2,000f (£80) for the description of the best method of achieving this result, and as several electrical engineers have been turning their attention to this point, the prospect of reward and honour may stimulate them to compete. The award takes place early next year, and papers must be sent in at once—before January 1.

Trolley Wheels.—The *Electrical World* comments on the adoption of the trolley conductor electric tramway at Walsall with a sort of amused smile at thoughts that the American system could be "improved," but at the same time hoping that it will be a success both for the sake of the railway and for their own—"as it certainly is an improvement from the æsthetic standpoint which we would be glad to introduce, if practical." Advice is given to the Walsall engineers that they should have their men well up in the art of replacing the trolley wheel after it has jumped off, as American ones are generally inclined to do when going at some speed. The question is asked: "Why 350 volts?"—if by English law, then is compassion expressed for those who pay the bills; but as 500 volts is the standard in America, "why should the English engineer want to go over the same ground again?"

Telephoning Sermons.—An interesting experiment in long distance telephoning was tried at the residence of the editor of the *Yorkshire Post* at Leeds, on Sunday evening, in the presence of a small party of friends. For about two years Christ Church, Birmingham, has been fitted with telephonic transmitters. On a few occasions the effect has been tried in towns at a distance of 50 [illegible] miles, and, as a rule, the service has been successfully transmitted. No attempt had yet been made until Sunday night to cover so great a distance—130 miles—as that involved in the connection between Birmingham and Leeds, which had to be established *viâ* Manchester. The service had in this case to pass through three exchanges—those of the three towns named—before it reached the party of listeners, who were furnished with a number of single receivers. The experiment was fairly satisfactory.

Electric Furnace.—M. Moissan has succeeded in obtaining a temperature of 3,000deg. C. with an electric furnace of lime bricks, using high-tension currents, the highest temperature obtained previously in the oxygen furnace of Deville and Debray being about 2,000deg. C. Near 2,500deg. C., M. Moissan found that lime, strontia, and magnesia crystallised in a few minutes. If the temperature rises to 3,500deg. C., the walls of the furnace melt. With the current of 50 h.p. the exterior of the furnace becomes red hot in a few minutes. Crystallisation of precious stones, such as rubies, have been obtained. The greatest precautions have to be taken in these experiments, both on account of the high potential, the great heat, and also for the effect on the eyes of the operator. The *Bulletin Internationale* states that another experimenter has made a number of similar experiments, and will shortly publish a paper on the subject.

Explosions.—Prof. A. Witz, of Lille, in a long study on boiler explosions (given in the *Comptes Rendus*) thus sums up his conclusions: "The greater number of explosions are due either to an original defect in the construction of the boilers, or to a state of decay, fatigue, or wear; it is, therefore, easy to reduce to a small fraction the chance of accident. A boiler well thought out in general form, well designed in details, constructed of good material according to the best practice, provided with proper safety apparatus, fed with properly-purified water (not muddy, greasy, or corrosive), not overloaded, inspected regularly, and conscientiously worked by an intelligent, sober, zealous and honest stoker, is, so to speak, inexplosible." He estimates the chances of explosion as 1 in 10,000, and of grave accident 1 in 20,000. This should reassure users of steam power, but not inspire them with a culpable negligence, which could only produce a false security.

Dangers of the Telephone.—The *Lancet* calls attention in a note to the latest outcome of competitive civilisation in the "telephone ear," which was foreseen and described by Prof. Lannois, of the Lyons Medical School. For ears which are not specially sound he considers the telephone contra-indicated, as even in a comparatively robust organ its continuous use is followed by symptoms more or less grave—cephalalgia, vertigo, hyperæsthesia, insomnia, and sometimes psychical disturbances of a character which might become chronic. He counsels a sparing use of the instrument in the case of those whose ears are sound and an absolute abstention from it in those

whose organs are already impaired from causes hereditary or induced. His memoir, which was read and discussed in a confirmatory sense at the Congress of Aural Surgeons held in Paris in 1889, will be found in the "Comptes Rendus et Mémoires," p. 265, for the same year.

Lighting Large Buildings. — Mr. T. Crichton Fulton delivered a lecture last week before the Edinburgh Architectural Association on the "Electric Lighting of Large Buildings." The lecturer explained the principles and practice of the electric lighting of buildings, and gave details of the arrangements employed and how they work. In describing various kinds of installations, he emphasised the importance of arranging the machinery, upon which everything depends, with plenty of space, light, and air so that it could be kept scrupulously clean. He described as typical installations a country house with water power, a factory in town with boiler power and a steam engine, and a large church with a gas engine for its prime motor. In speaking of the first case—the country house with water power—the lecturer pointed out the advantages to be derived from the use of turbines, and explained the use and importance of storage batteries in such a case. In concluding, he dwelt strongly on the propriety of having all work properly designed from the beginning, and thoroughly inspected and tested whilst in progress. A cordial vote of thanks was passed to Mr. Fulton for his lecture.

House Lighting.—The electric mains come to a man's door, his wife urges him to have the light, he thinks it over, finds out the price, looks and longs, and finally orders. Often, if intelligent, he buys a book "about the electric light" first. At any rate, if he finds one on a bookstall he pays his shilling, and perhaps gets what he wants. More probably he still is left in wonder at electricity, but if the book is a good one he learns something definite about the light, and is content. Mr. Angelo Fahie has written such a book for purchasers—"House Lighting by Electricity" (Spon and Co.)—short, clear, and practical, with explanations of principles and terms, illustrations of lighting and heating apparatus, as well as motors, and, what the purchaser will desire, a set of estimates. In the explanation it is doubtful if labelling the electric action "induction" without other explanation will clear the householders' ideas on "transformers," and the theory of the dynamo naturally cannot be very fully given in a page. Nevertheless, a good deal of practical information is given in the 80 pages of the work. One could have wished to have seen it without the very modern Venus cover.

Electro-Metallurgy.—Mr. J. W. Swan delivered a lecture on "Electro-Metallurgy" last week before the Newcastle Literary and Philosophical Society, dealing with the history of the industry and illustrated with numerous interesting experiments. He referred at the conclusion to the College of Science in that town, for which money was yet needed. When the college scheme was fully carried out, as he trusted it would be at no distant date, Newcastle would possess a technical teaching institution second to none in the kingdom in point of appliances and efficiency—an institution entirely worthy of the position and reputation of the town as a centre of manufacturing industry, and a most effective instrument in maintaining and extending its prosperity. The experiments shown at the lecture were greatly appreciated, especially that of the welding on the table, and before everyone's eyes, of pieces of metal by the electric arc, performed personally by Mr. Unwin. The performing of this practically in a lecture hall is a work of some difficulty. The electric energy was supplied by Messrs. Holmes and Co., of Newcastle. The light evolved was so intense that the operation had to be witnessed through screens of ruby glass. Cordial votes of thanks were given to the lecturer and chairman.

Crystal Palace School of Engineering.—Last Saturday afternoon the certificates awarded by the examiners for the winter term to students attending the Crystal Palace Company's School of Practical Engineering were distributed by Mr. W. H. White, C.B., the assistant controller and director of naval construction of the Admiralty. The examiners, Messrs. A. G. Drury, C.E., Thomas Inman, C.E., and J. G. W. Aldridge, C.E., who inspected the mechanical, the civil engineering, and electrical sections of the school respectively, reported that the number of students who had attended the lectures during the term was 58, of whom 39 had satisfactorily passed, and that the work done in the different departments was of a very creditable character. In an address to the students, Mr. White took the nobleness of the profession of engineering as his text. He thought they might, without any accusation of undue claims, say that engineering was a profession—nay, that it was a learned profession in these days. If a man was to hold his own in any branch of engineering, he required to be as studious and as well informed in his own subjects as any man could be in any branch of learning whatever. And, even as regards range of subjects, he maintained that neither the clergyman, the doctor, nor the lawyer had greater demands made upon him than had the engineer. The certificates were then presented to the students. Mr. J. W. Wilson, C.E., principal of the school, also spoke, and a vote of thanks was passed to Mr. White.

The Deri Electromotor.—Herr Déri, the well-known Hungarian electrical engineer, has been working at the problem of constructing a direct-current motor without self-induction. In *Electricité* (December 15), M. F. Guilbert gives some account of the new Déri motor recently patented, and illustrates the windings and the curves, of effective E.M.F. of the machine. Several different methods of winding are employed, the same in general principle. The coils on the armature core are wound so that the end of each circuit is connected to the commutator segments diametrically opposite. The extremities of each circuit come simultaneously into contact with the two brushes which lead in the current. The brushes are made large enough to touch several commutator bars, which puts the coils out of action in short circuit. In order to reduce the air gap, the coils are disposed symmetrically, and the arrangement can be used identical with the Gramme ring, but connected as described. Another method of winding is also used. The principle is the same, but each circuit has the direction of winding changed, equally spaced, and in number double that of the poles of the field magnets—for a two-pole motor, four inversions. Other arrangements are suggested. The fact that during rotation each circuit is only traversed momentarily by the current allows the current in the armature to be very much greater than in the armature of an ordinary motor, while allowing the same heating and same loss of energy. The exact action of induction due to fields and due to rotation of armature are investigated by Herr Déri. The motor is easily regulated to any speed by adjusting the brushes.

The Inventors of the Telegraph.—Prof. Thomas Gray, of Terre Haute, Ind., celebrates the beginning of the second century of the American patent system by an address on the "Inventors of the Telegraph and Telephone," giving in succinct form the history of these inventions. From the discovery of Stephen Gray in 1729 that electrical influence could be conveyed to a distance by insulated wire, of Romagnosi in 1805 of the deflection of a needle, rediscovered by Oersted, to the inventions of

Schweigger, and Schilling, and Steinheil, up to Morse, the gradual evolution of the telegraph is traced. The influence of the researches of Prof. Henry receives adequate recognition in this paper, and his claims are quoted: "(1) Previous to my investigations, the means of developing magnetism in soft iron were imperfectly understood, and the electromagnet which then existed was inapplicable to the transmission of power to a distance. (2) I was the first to prove, by actual experiment, that in order to develop magnetic power at a distance a galvanic battery of 'intensity' must be employed to project the current through the long conductor, and that a magnet surrounded by many turns of one long wire must be used to receive this current. (3) I was the first to actually magnetise a piece of soft iron at a distance, and to call attention to the fact of the application of my experiments to the telegraph. (4) I was the first to actually sound a bell at a distance by means of the electromagnet. (5) The principles I had developed were applied by Dr. Gale to render Morse's machine effective at a distance." Which is the better-known name, asks Prof. Gray, that of Henry or Morse? and he pertinently adds, "Would not Henry have gained both in popularity and in scientific reputation if he had patented and made the public pay liberally for his discoveries?"

Electricity in Agriculture.—A series of articles, which should have good effect in spreading the use of electric motors, is being given in the *Electrical World*, entitled "Applications of Electricity to Agricultural Work." The importance that electricity is likely to exercise in agricultural operations is hardly yet realised, even in America. Such articles ought to be copied and widely published in the daily journals, for they contain much that the public is waiting for. With exhibitions on the one hand for occular demonstration and with descriptive articles on the other—so that the various arrangements may be thought over and settled by the intending customer—there certainly should be an ever-extending field for motor application in homestead and agricultural work. A bit of a stream somewhere near (providing it has a fall), with a small turbine and dynamo should supply, besides lights, the motors for washing, churning, milk separating, cider presses, as well as, perhaps, heat for ironing, baking, and what not. We suggested a little while ago that it would pay the electrical engineer to study house-warming, pumping, and dairy requirements, and make these arrangements part of his profession. After all, what is it that is wanted but the "application of natural forces to the needs of mankind"? Light is but one out of many of these needs. The organisation of life requires codification—reduction to a well-understood plan, and the means of doing this in an ideal manner lies in the hands of the electrical engineer. It will be well for him to pay attention to these matters from the point of view taken in the articles above mentioned, and do his best to extend the knowledge of the applications of electricity to useful everyday life. One well advertised example, which could be visited easily, of a thorough and complete homestead installation, where everything was done by electricity from top to bottom, would be far more effective to the general public than many exhibits of single applications. Business would not be wanting to men who laid themselves out in this manner to satisfy the whole demands of enquiring proprietors.

A Universal Transformer.—Signor Giulio M. Appolonj, of Rome, describes in the *Electrical World* for December 10 what is termed a universal transformer, in three types of the same general design but of modified detail, according as they are required (1) to transform a continuous current of one pressure into a continuous of another pressure; (2) a simple alternating current into a continuous current, or *vice versâ*; (3) a polyphase current into a continuous current, or *vice versâ*. The apparatus is ingenious, and theoretically interesting, though no figures or results are given. Imagine a heavy ring core built up of iron discs in the usual way. In the body of each disc are stamped out eight square holes, so that the resultant ring core has eight apertures through its substance. Through an aperture wind copper windings, passing over and over to the outer edge of the ring, then from the coil so made pass to the next aperture in series, and so round the whole eight apertures. This constitutes, say, the primary circuit. Now, with the same apertures wind secondary coils passing to the inner edge of the ring, first in one aperture, then passing to the next aperture in series, and so on for the whole number. It must be realised that this arrangement gives two Pacinotti rings rigidly connected together. Add two commutators and make the two sets of brushes revolve, and the result will be that if a continuous current is sent in at one pair of brushes a continuous current will come out of the other pair, the potential being, of course, dependent upon the size of the wires. So far the continuous-current transformer. It can easily be seen that for the second type, to convert continuous into alternating, or *vice versâ*, all that is necessary is to omit one of the commutators. The second type, therefore, has a Pacinotti ring inside with commutator and a set of wires on the exterior half of the ring, simply arranged to produce four poles corresponding to those produced internally when the current is introduced. The one set of brushes leading in continuous currents is made to revolve, and produces in the other circuit an alternating current, of high or low potential according to the winding. As the apparatus is reversible, it follows that we should have the simple apparatus so long desired of at once transforming any alternating current to a continuous current of any desired potential. The third type, the polyphase transformer, has six apertures only, with three coming in wires: for the exterior circuit attached at an angular distance of 120deg. from each other. If a continuous current is sent through the revolving brushes, three alternating currents will be produced in the outside circuits, displaced 120deg.; and *vice versâ*, if such polyphase currents are sent into these three wires, the revolving brushes will draw off continuous currents. With these three types it is claimed any transformation of current can be obtained, coupled with redressing—continuous, alternating, or multiphase. These advantages are obvious. There are besides several essential advantages. In the first place, there are no heavy pieces in motion—the brushes can be moved by an insignificant fraction of a horse-power; in the second place, the transformer is not costly. It is especially suitable for charging accumulators in transmission of power at high potential by continuous currents. The second type is adapted for alternating-current systems, for charging accumulators, and for electric traction. So far, no electric railway has been run by alternating currents, as synchronous motors are impracticable for traction. With the above apparatus this is claimed possible, because it allows of redressing into continuous current, accompanied by a lowering of the voltage. In the case of long railways this might be done on the locomotive itself, while for ordinary tramways the transformers could feed into the trolley mains. For the transmission of power these transformers would permit the use of continuous current motors on alternating current circuits. The practical questions that present themselves are: what about sparking and the lag effect of varying the load? It would be interesting to have the result of tests.

FIELD MAGNETS.

BY GISBERT KAPP, M.I.C.E.

(Continued from page 611.)

Multipolar Fields.—An example of a multipolar field has already been given in Fig. 2. This is the double four-pole magnet used by the Brush Company in their "Victoria" dynamo. The armature is a ring of large diameter as compared to its length, and the poles are presented to the end faces from either side. We require thus eight magnet cores with their axes parallel to the spindle, four on either side. The outer ends of the cores are joined by two massive cast-iron yokes. Fields of this type are frequently used in alternators.

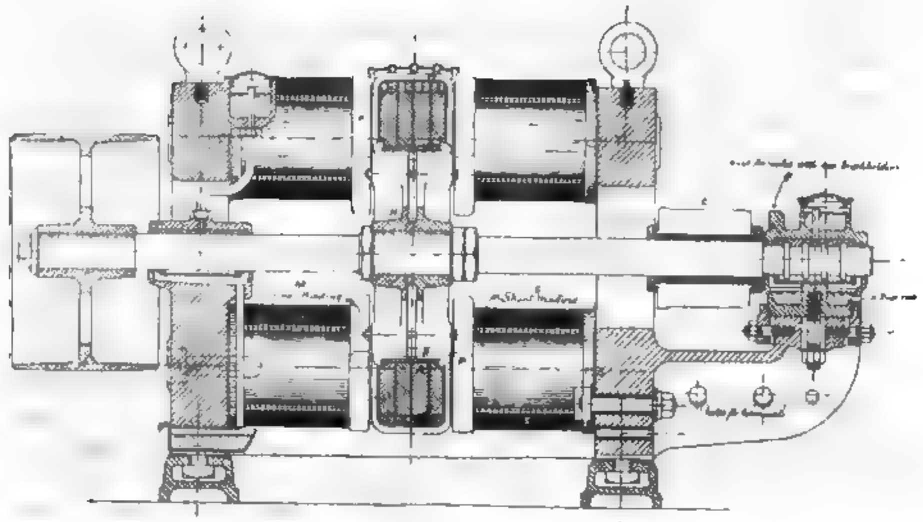

FIG. 2.

In machines with cylindrical armatures (whether dynamos or alternators) the pole-pieces are necessarily parts of a cylindrical surface, and the axes of the magnet cores are generally at right angles to the spindle. Any multipolar field may be considered as a combination of

FIG. 58.

bi-polar fields. Thus, by taking two fields of the type 57c, we can produce a four-pole field of the type 58. In a similar way Fig. 59 may be considered to result from Fig. 57e if we increase the curvature of the yoke so as to get room

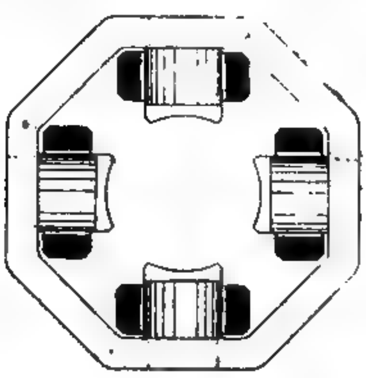

FIG. 59.

for another pair of magnets. The coupling up of the coils must in this case be reversed, so that diametrically opposed poles have the same, and neighbouring poles the opposite sign. By duplicating Fig. 57f, we obtain the field shown in Fig. 60. In this design four poles are produced by the use of only two exciting coils. Fig. 61 may be considered to result from the combination of four fields of the type shown in Fig. 57a. If a field of more than four poles be required, we may produce it by combining three or more fields of the 57c type; but this presents considerable mechanical difficulties in supporting the magnets, and is also, for other reasons, less advantageous than an expansion of the arrangement, Fig. 59, which is shown in Fig. 62 as applied to a 10-pole machine. Fig. 61 may also be expanded into a field of six, eight, or more poles, and is with continental makers a favourite type. Another type exclusively used on the Continent is the reverse of Fig. 59, the poles being placed inside the armature, which must in this case be overhung, the active conductors being on the inside. Fig. 63 shows a 10-pole field of this kind. To give an idea of the relative weight of armature in Figs. 62 and 63, the outlines of the armature core have been inserted in the diagrams, which represent machines of equal output and equal speed. The field of Fig. 63 is about half the weight of Fig. 62, but this advantage is bought at the cost of a more difficult mechanical construction, both as regards the support of the armature core and the positive driving of the armature conductors.

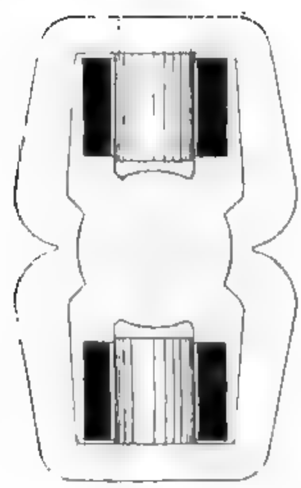

FIG. 60.

There is no hard-and-fast rule by which we can judge the merit or otherwise of any of these types of field. The voltage, size, and speed of the machine, the greater or lesser importance of small weight, the possibility of obtaining soft steel castings, the relative cost of copper and iron, the energy permitted for excitation, the temperature rise allowed, and, last, but not least, the skill of the designer, are all items on which the value of any type depends; but, as a general guide, a few facts may here be usefully stated. If pole-plates are used with Fig. 58, whereby it is possible to make the section of magnets not too much different from a square,

or if the armature is fairly short, whereby the magnet's section naturally approaches a square, the amount of exciting wire required is not excessive, and the total weight of field is very moderate. As far as iron and copper are concerned, this type of field is fairly cheap, but the mechanical support of the magnets is somewhat expensive because it must be formed entirely of gunmetal brackets or chairs. Another drawback is that there is little ventilation for the armature and less for the inside of the field coils, so that

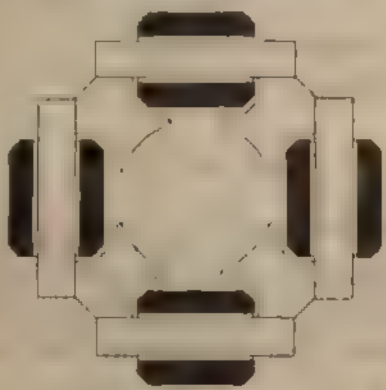

Fig. 61.

the heating will be greater than in machines of less compact design. Fig. 59 requires the same amount of magnet wire or possibly a little less than Fig. 58, but the whole field is much heavier if the yoke be made of cast iron. If the yoke be made of soft cast steel it need only be from one half to one third the section of the cast iron yoke, and then Fig. 59 becomes lighter than Fig. 58. There is the further advantage that no gunmetal supports are required, the field being of the iron clad type. The whole design is more open than Fig 58, and the ventilation of armature and magnet coils is better.

Fig 60 is a very simple design and requires about the same amount of copper as Figs. 58 and 59; it is, however, very heavy if cast iron be used for the yoke. With cast steel the weight may be brought down to less than either of the previous designs, especially in small machines. The fact of the armature and field coils being protected by the surrounding yoke renders

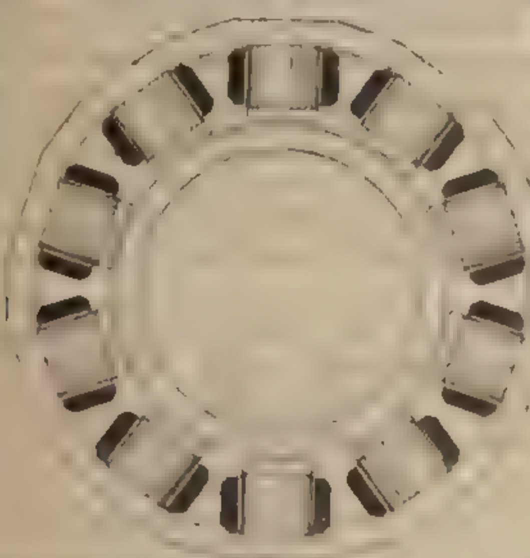

Fig. 62.

this design suitable for machines which are exposed to rough usage, such as tramway motors. Machines of this type have also been used for shiplighting, where an iron-clad field has the advantage of not disturbing the compasses. The field shown in Fig 61 is heavy and expensive. It requires gunmetal supports and rather more wire than Fig 58, but the cooling surface of the coils is large and the ventilation very good. This type is used for 10 and more poles in the newest design of Edison central station machines, and an example is also furnished by the new generator of 300 kilowatts (2,400 amperes at 125 volts) used for the distribution of electrical energy for motive power throughout a small-arms factory near Liége.* In this machine, which is more remarkable for its dimensions than its output, the armature is 15ft. 9in diameter, and the field has 20 poles. The magnet cores and poles are of soft cast steel and weigh 10 tons, whilst two

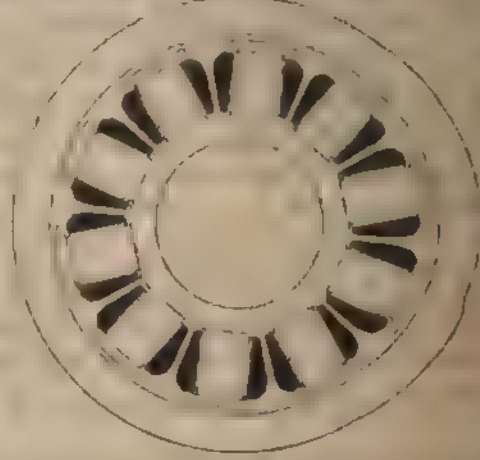

Fig. 63.

tons of exciting wire are used. The speed of the machine (which is direct driven by a Van der Kerchove engine) is 166 revolutions per minute, giving the armature the remarkably high peripheral speed of over 8,000ft per minute. At this speed the weight of field is about 90lb per kilowatt output. In machines of the type, Fig. 58, the weight of field is under 100lb per kilowatt for a peripheral speed of armature of 2,000ft per minute. This is three and a half times better than the condition of the Liege machine the field of which is of the type shown in Fig. 61, but expanded to 20 poles.

Weight of Fields.—A rough comparison of the different types of field as regards their weight has been made above, but in order to bring this important matter more clearly into view, it appeared to me desirable to give the reader some examples actually worked out so that he could compare figures rather than mere general statements. The figures given refer, of course, only to the particular cases

Fig. 64.

selected, and their relative value would come out differently if we made the designs for a larger or smaller output, or a different speed or different armatures. In order to get representative figures it was, therefore, necessary to select

Fig. 65.

fairly representative cases, and I have chosen for two-pole machines an output of 25 kilowatts, at 550 revolutions, as being about midway in the range of output and speed for which two-pole machines would usually be adopted. The armatures are 12in diameter by 15in long, and have, therefore, a peripheral speed of 1,730ft. In two cases the armatures are 15in by 15in, and have a peripheral speed of 2,160ft. For the fields having four poles I have chosen an output of 80 kilowatts, at a speed of 500 revolutions, as being fair average conditions for which four-pole

* L'Electricien, vol iv., No 39, p 177, September [illegible] 1892.

machines would be employed. The armatures are in all cases 24in. diameter by 20in. long, and have a peripheral speed of 2,380ft.

Before giving the results of this investigation it is necessary to say a few words on the methods employed in designing the fields. The laws which govern the amount of exciting power or ampere-turns for any given configuration of magnets will be found below in this and the next chapter. For the present it is only necessary to state that these laws have been followed in determining the amount of field wire required, and that due regard has been paid to armature reaction, heating limit, and percentage of exciting energy. Where advisable, pole-horns or pole-plates have been added to reduce exciting power or length of wire; and in two cases (Figs. 64 and 65) the poles have been cut so as to reduce armature reaction and permit the use of a lighter field. The armature in these two cases has been increased to 15in., and is, of course, heavier and more expensive than the 12in. armature, which is used throughout the other two-pole fields. In all the two-pole machines the armature is designed for a copper loss of $3\frac{3}{4}$ per cent. Precisely the same armature (24in. diameter by 20in. long) is used in all the four pole fields, and it has been designed for a copper loss of $2\frac{1}{2}$ per cent.

As regards the copper loss in the fields this has been limited to $3\frac{1}{2}$ per cent. in the two pole and to 2 per cent. in the four-pole fields, except in those cases where the heating limit made it desirable to work with a smaller expenditure of power in the field. The temperature rise has been determined in every case, and will be found in the table below. The weights given are simply for the iron in the magnetic circuit and for the copper wire, but do not include the weight of any formers, terminals, chairs, and support for the magnets. For convenience of comparison I have added the weight of magnets per kilowatt output, on the supposition that the peripheral speed of the armature is in all cases 2,000ft. per minute. The magnet cores are in all cases of wrought iron; the poles are of cast iron in 57a, 57b, and 64. The yokes are of cast iron in 57c, 57e, 57f, 59, and 60.

Field Magnets for Two-Pole Machines.—25 kilowatts output, 650 revolutions.

Type of Field. Fig.	57a.	57b.	57c.	57d.	57e.	57f.	64.	65.
Total weight of field, lbs.	5,090	4,670	3,020	2,790	6,750	5 070	3,670	2 400
Weight of iron, lbs. ...	4,600	3,600	2,600	1,800	6,400	4,600	3,000	1,750
Weight of copper, lbs ..	490	1,070	420	990	350	470	670	650
Percentage of output required for excitation	3	3·5	3·5	3·5	3·25	2·8	3·5	3·5
Temperature rise, degrees centigrade	33	25	33	20	33	33	28	22
Weight of field in lbs. per kilowatt at 2,000 feet peripheral armature speed	175	160	104	96	230	175	155	104

Field Magnets for Four-Pole Machines.—80 kilowatts output, 380 revolutions.

Type of Field. Fig.—	58	59	60	61
Total weight of field, lbs.	6,070	9,880	10,980	7,300
Weight of iron, lbs.	4,400	8,700	9,600	4,700
Weight of copper, lbs...........	1,670	1,180	1,380	2,600
Percentage of output required for excitation	2	2	1·94	3
Temperature rise, degrees centigrade ..	30	36	33	35
Weight of field in lbs. per kilowatt output at 2,000 feet peripheral armature speed	90	147	163	109

Determination of Exciting Power.—The law which governs the production of magnetic flux by the application of a certain magnetic force has already been given, and it is by applying this law to special cases that we find the total exciting power measured in ampere-turns that is required to produce in dynamo magnets a definite flux, or total field. In what follows, the letter F will be used to denote the total flux in C.G.S. measure, and the letter Z will be used to denote the same quantity in English measure—or, $F = 6{,}000\ Z$. The exciting power in ampere-turns we denote by the letter X, so that the general equation (22) can also be written

$$X = F R \quad . \quad . \quad . \quad . \quad . \quad . \quad (33)$$

R being the magnetic resistance as defined in Chapter V., and being found by the formulæ:

$$\left.\begin{aligned} R &= \Sigma \frac{1}{1{\cdot}256} \frac{L}{A} \frac{1}{\mu} \\ \text{or, } R &= \Sigma \quad {\cdot}8 \quad \frac{L}{A} \frac{1}{\mu} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (23)$$

Or, in English measure,

$$X = Z R \quad . \quad . \quad . \quad . \quad . \quad (34)$$

where

$$R = \Sigma\, 1{,}880 \frac{L}{A} \frac{1}{\mu} \quad . \quad . \quad . \quad . \quad (25)$$

In this expression the length of the circuit, L, must be inserted in inches, and the area, A, in square inches; μ being merely a numeric, remains the same in both systems of measurement. In the special case that the part of the magnetic circuit under consideration contains only air or other non-magnetic substance μ becomes 1, and we have

$$R = {\cdot}8 \frac{L}{A} \qquad\qquad R = 1{,}880 \frac{L}{A},$$

since $F = \mathfrak{B}\ A$, and $Z = B\ A$, we find the ampere-turns required to produce the flux, F, in air by $X = \mathfrak{B}\ A \times {\cdot}8 \frac{L}{A}$

$$X = {\cdot}8\ \mathfrak{B}\ L \quad . \quad . \quad . \quad . \quad . \quad (35)$$

and similarly for English measure

$$X = 1{,}880\ B\ L \quad . \quad . \quad . \quad . \quad . \quad (36)$$

It is generally convenient to determine the exciting power separately for each part of the magnetic circuit, because the flux is not the same in all its parts. In a dynamo machine we have to distinguish between the flux through the armature, that through the air space (assumed to be the same), and that through the pole-pieces, joints, magnet cores, and yokes, which is always larger than the armature flux, because a certain proportion of the lines generated within the magnet coils never passes through the armature, but produce what is termed a leakage field through the air surrounding the exciting coils. Since leakage is simply a magnetic flux through air, and must follow the general law $F = \frac{X}{R}$, it will be seen that the amount of leakage must depend on the extent of the surfaces which are under different magnetic potentials, their distance apart, and on the difference of magnetic potential or magnetomotive force. Generally speaking, the leakage will be the greater, the greater the exciting power the larger the external surfaces of pole-pieces, and the less the distance between poles of opposite sign or between poles and yokes.

The magnetic resistance of joints is generally neglected, and in well-made machines, where the joints are properly faced and strongly pressed together mechanically, their resistance is quite insignificant compared to that of other parts of the circuit. Prof. Ewing* has experimentally investigated the magnetic resistance of joints by observing the decrease of induction with the same magnetising power in a bar which had been successively cut into two, four, and eight pieces. He found that by applying mechanical pressure to the joints their resistance was diminished, and since in a well-made machine the joints are either strongly bolted up or are a good driving fit, we may take it that the necessary mechanical pressure for a good magnetic fit is obtained. Ewing gives the resistance of the joint in comparison with an equivalent layer of air between the surfaces. For $H = 30$, and $\mathfrak{B}$ varying from 14,550 to 9,800, the equivalent layer of air is ·002 centimetre thick. For $H = 50$, and $\mathfrak{B}$ varying from 15,950 to 13,300, it is ·0013 centimetre thick, and for $H = 70$, and $\mathfrak{B}$ varying from 16,820 to 15,200, it is ·0009 centimetre thick. If we calculate from Ewing's figures what exciting power is

* *Phil. Mag.*, Sept., 1888.

required to overcome in each case the resistance of the joint, we come to the remarkable result that with an increasing induction the exciting power actually diminishes. We find for

$$\mathfrak{B} = 12{,}175 \left\{ \begin{array}{c}\text{ampere-turns required to overcome} \\ \text{resistance of joint}\end{array} \right\} = 19{\cdot}6$$

$$\mathfrak{B} = 14{,}625 \quad \text{,,} \quad \text{,,} \quad \text{,,} \quad = 17$$

$$\mathfrak{B} = 16{,}020 \quad \text{,,} \quad \text{,,} \quad \text{,,} \quad = 11{\cdot}6$$

This result may possibly be due to the fact that with the greater induction the magnetic attraction is also increased, and thus the contact of the joints in Ewing's experiments may have become better as $\mathfrak{B}$ became larger. The conditions of the experiment were, therefore, not exactly those obtaining in a system of heavy field magnets, where the joints are in any case under great mechanical pressure. For the rest it is a matter of indifference whether we allow 10, or 50, or 100 ampere-turns for the resistance of each joint, because the total exciting power is reckoned not by tens, but by thousands of ampere-turns, and we are thus justified in entirely neglecting the resistance.

There remain thus only three parts of the magnetic circuit to be separately dealt with—namely, armature, air spaces, and magnets—including poles, cores, and yoke. To find the total exciting power we have merely to determine separately the exciting power, X_a, required to drive the flux through the armature, that required for the air space (which we call X_α), that required for the magnet cores and poles (X_m), and that required for the yoke (X_y). We shall use the same indices, a, α, m, y for F or Z, and $\mathfrak{B}$ or B to distinguish respectively the flux and induction through the various parts of the circuit. The following symbols will also be used:

L_a = average length of path of lines through armature core;

δ = length of air gap or interpolar space;

A_a = net area occupied by iron in armature core;

A_α = area of air gap;

A_m = cross-sectional area of magnet cores;

A_y = cross-sectional area of yoke;

L_m and L_y = length of paths through magnets and yoke respectively.

(To be continued.)

VESTRY OF ST. PANCRAS.

[The report on the introduction of electric lighting has just been issued, signed by Mr. T. Eccleston Gibb. The first portion is historical, showing how St. Pancras came to deal with the matter. Below we give the latter part of the report, containing all the figures relating to the cost and to the working, figures of the utmost importance at the present time when so many municipalities are concerning themselves with this question.—Ed. *E. E.*]

The works required were advertised for to be carried out under seven contracts, and were let as follows: No. 1, buildings, Kirk and Randall; No. 2, boilers, Babcock and Wilcox, Limited; No. 3, engines, dynamos, etc., Willans and Robinson, Limited; No. 4, switchboards, The Electric Construction Corporation, Limited; No. 5, batteries, The Electric Construction Corporation, Limited; No. 6, trenches, Mowlem and Co.; No. 7, electrical conductors, Clark, Muirhead, and Co., Limited.

The following is a statement of the total cost of the installation, including the estimated cost of works not yet completed, and marked below with an asterisk:

Site.	£	s.	d.
Paid for freehold site, including houses in Longford-street reserved for extensions	10,000	0	0
Interest on purchase-money	21	7	5
Compensation for subsidiary interests and loss of rent	292	18	0
Law charges	169	5	10
Clearing the site	40	17	6
	£10,524	9	3

Obtaining Loans.			
Loan from the London County Council for £10,000	£29	15	5
Loan from the Prudential Assurance Company for £60,000	115	14	[illegible]
	£145	10	5
Station and Sub-Station.			
Buildings	7,906	2	[illegible]
Boilers, pumps, etc.	4,617	1[illegible]	[illegible]
Engines and dynamos	18,180	7	5
Switchboards	1,373	5	10
Batteries	2,961	0	1[illegible]
	£35,02[illegible]	13	[illegible]
Street Trenches and Electrical Conductors.			
Trenches	13,167	1[illegible]	[illegible]
Conductors	17,90[illegible]	15	1
*Extensions nearly completed exclusive of those for public lighting	3,820	0	[illegible]
	£34,89[illegible]	5	[illegible]
Instruments, Meters for Hire, etc.			
Electrical instruments	[illegible]	[illegible]	[illegible]
General machinery, tools, etc.	1[illegible]	7	[illegible]
Office and committee-room fixtures, etc.	1[illegible]	[illegible]	[illegible]
Meters for hire, switches, fuses, etc.	1,281	13	[illegible]
General stores	9[illegible]	1[illegible]	[illegible]
	£2,755	[illegible]	[illegible]
Public Lighting.			
†Tottenham Court-road and part of Euston-road	1,332	[illegible]	[illegible]
*Euston-road to King's Cross	1,400	[illegible]	[illegible]
*Euston-road to "Brecknock," Camden-road	4,750	[illegible]	[illegible]
	£7,482	[illegible]	[illegible]
Miscellaneous.			
Fees to Dr. Hopkinson and Mr. Preece for reporting on Prof. Robinson's scheme	157	1[illegible]	
Committee's expenses for electrical papers, books, etc.; inspecting works in progress	44	1[illegible]	[illegible]
Solicitor's charges for settling contracts, agreements, licenses, questions respecting use of pneumatic tubes, rights of light, etc.	104	[illegible]	[illegible]
Messrs. Theobald Bros. and Miall, designing books, etc., to meet Board of Trade regulations	52	1[illegible]	[illegible]
Printed books, forms, etc.	32	11	[illegible]
Advertising, notice-boards, etc.	44	[illegible]	[illegible]
Contribution towards the expenses of the St. Pancras Electrical Exhibition	2[illegible]	[illegible]	[illegible]
	£457	[illegible]	[illegible]
Grand total	£91,4[illegible]	1[illegible]	[illegible]

Summary of Receipts and Expenditure.

CAPITAL ACCOUNT FOR INSTALLATION.

Receipts.	£	s.	d.
London County Council	10,000	0	[illegible]
Prudential Assurance Company	60,000	[illegible]	[illegible]
Rents of reserved portion of site, Longford-street houses, £519. 0s. 2d., less repairs, rates, taxes, insurance, etc., £126. 8s. 8d.	392	11	[illegible]
National Bank, temporary advances	13,797	1	[illegible]
Balance due on completion of works in hand	7,303	1[illegible]	1[illegible]
	£91,493	12	[illegible]

Expenditure.	£	s.	d.
Site	10,524	9	3
Cost of obtaining loans	145	10	[illegible]
Station and sub station	35,034	13	[illegible]
Street trenches and conductors	34,894	5	[illegible]
Instruments, etc.	2,756	[illegible]	[illegible]
Public lighting	7,482	[illegible]	[illegible]
Miscellaneous	457	[illegible]	[illegible]
	£91,493	12	[illegible]

Some remarks are necessary with reference to a few of the items in the above statement:

(*a*) The land reserved for extension of works, and upon which the Longford-street houses stand, is capable of accommodating sufficient plant whereby the present output of current may be more than doubled.

(*b*) The total expenditure for street trenches and conductors, including the extensions in hand, is £34,894. 5s. 9[illegible] The original expenditure contemplated provision for current equal to 25,000 16 c.p. lamps and 90 arc lamps, although the machinery was designed for only 10,000 16-c.p. lamps and 90 arc lamps. This was necessary, as it could not be

* The three items marked *, amounting in the total to £[illegible], represent estimates for extensions, a large proportion of which [illegible] already completed and measured up. The whole of the works will, [illegible] doubt, be carried to completion for a sum less than the estimate [illegible] from £400 to £600.

† Mains not included.

foreseen where the current would be taken up. Since we commenced to supply it has been necessary to extend still further the original provision to meet demands in places not included in the scheduled area, so that now we have provision for more than 30,000 16-c.p. lamps, as well as the 90 arc lamps. The result of this is that at present nearly two-thirds of the capital expended on trenches and conductors, say, £20,000, is lying idle, and must continue to do so until further generating plant is put down at the station. The arc lamp plant will be fully charged as soon as the lamps now being erected are put in lighting, so that the arc lighting plant also must be extended before any* more public lighting can be undertaken.

(*c*) The amount expended for meters, switches, and fuses is £1,181. 13s. 8d. Of this sum about £1,000 is for meters, which are lent on hire, and which are a distinct source of revenue to the Vestry.

(*d*) The amount representing the value of general stores is large. Certain articles of stock, representing nearly half the total of £931. 10s. 4d., must be idle for the present, owing to a decision of the Board of Trade that the mains for public lighting should be kept distinct from those for private supply. This is not a dead loss, as the material can be utilised on further extensions.

(*e*) The extension of public lighting to King's Cross and The Brecknock will add but little to the expenses hitherto incurred for lighting Tottenham Court-road and part of Euston-road, as the plant which has had to be worked for a portion will be sufficient for the whole.

(*f*) The expenditure upon public lighting includes the cost of constructing the new street rests in Tottenham Court-road and other places where arc lamps have been erected. These rests are looked upon as a general public convenience, and might be considered a fair charge on the general rate.

(*g*) In the summary of receipts and expenditure, the amount shown as a temporary advance from the National Bank represents only that part of the total sum advanced by the bank, which is attributable to capital expenditure. The item of £7,303. 19s. 11d., the balance of the account, is not yet due, although the works are in hand, and it represents part of a larger sum upon which advances to the extent of £2,666. 0s. 1d. have been made. The advantage which the Vestry have had through obtaining this temporary accommodation from the bank, instead of obtaining a further loan earlier, is that only 3 per cent. interest has been paid upon the money instead of 3½ charged by the County Council and the Prudential Assurance Company, and there have been no instalments to pay off.

First Year's Working.

In giving particulars of the first year's working, it must be remembered that the officers and servants were appointed in September, and in one or two cases earlier, and that from that date the installation was worked for the purposes of testing, etc. There was other expenditure also for coal and other things, from which no remunerative return could be derived.

The following statement shows the working expenses from the commencement down to the 8th November, 1892, on which day the first year ended from the date the supply of current was commenced. Some of the expenditure therefore dates back for a year and a half, and even longer :

Coal	£2 306	15	2
Water, oil, waste, etc.	356	17	1
Salaries	689	6	11
Wages	2 301	17	4
Printing and stationery	187	7	10
Advertisements	35	3	9
Electrical papers for committee	18	16	10
Committee's expenses on view	20	0	10
Repairs	171	15	1
Insurance	79	12	9
Cost of meter connections (charged to consumers)	137	7	11
Licenses	19	11	5
Carbons for arc lighting	110	11	7
Other charges	119	1	1
	£6 552	5	7

* Two dynamos have been erected for the 90 arc lamps—one being kept as a stand-by in case of accident. If two more machines were erected, the one stand-by would still cover any risk, and 270 arc lamps could then be supplied. These 270 arc lamps would be sufficient to displace the whole of the 1,200 gas lamps within the area, which can be economically served from the present station.

Summary of Receipts and Expenditure on Working Account.

Receipts.	£	s.	d.
Current supplied from 9th November, 1891, to 30th September, 1892	4,691	2	5
Current supplied during October, 1892	1,023	5	2
Current supplied for eight days in November (estimated)	290	0	4
Current for public lighting	1,411	17	9
Current for public urinal	39	15	9
Works for private consumers—meter connections	148	15	4
Sundry small receipts	15	8	10
	£7,620	5	7

Expenditure.	£	s.	d.
As per statement above	6,552	5	7
Balance towards payment of interest and repayment of loans	1,068	0	0
	£7,620	5	7

With regard to the foregoing statements on the first year's working, I desire to make a few observations.

(*a*) It has been already pointed out that the expenditure is for more than a year. It may also be said that the expenditure has been upon a plant which for a large part of the time has not been doing a tithe of the work it was capable of doing. During last winter we had few customers, and during the summer but little light was required.

(*b*) In the above summary the receipts for current from the 9th November, 1891, to the 30th September, 1892, was only £4,691 3s. 5d., whereas during the month of October, when the plant was still not in full use, the receipts amounted to £1,023 5s. 2d. From this it may be expected that the total annual income from this source will be, without any extension of plant, etc., at least £10,000* a year, and this is exclusive of the value of current used for public lighting, which will add another £3,000 or so.

(*c*) With reference to the balance shown of receipts over expenditure of £1,068, it will be noticed that this is but a small contribution towards the amount charged for interest and instalments of principal. This point will be referred to in the cash statement later on. It may also be observed that nothing has been allowed for depreciation. The reason for this is that the six months' maintenance under the contracts has but recently expired, and some of the plant has been scarcely used as yet. No large provision for depreciation ever will be necessary, because electric lighting plant must be kept in perfect condition by continuous repairs and renewals in detail.

Cash Statement—Capital Account.

Receipts.	£	s.	d.
London County Council	10,000	0	0
Prudential Assurance Company	60,000	0	0
Rents	392	11	6
†Loan required to balance	21,854	3	4
	£92,246	14	10

Expenditure.	£	s.	d.
Preliminary expenses	753	2	4
Cost of installation and extensions in hand	91,493	12	6
	£92,246	14	10

Conclusion.

Having in view the absolute necessity for further expenditure to meet the constantly increasing demands for current and to put in use plant now lying idle, the Vestry should at once borrow a further £30,000, making the total capital for this installation £100,000. If only £21,854. 3s. 4d. is borrowed it will be sufficient to clear off the total indebtedness to the National Bank; but it will only leave about enough to recoup the £2,908. 5s. 7d. which has already been paid for interest and repayment of loan.

The expenditure made by the Vestry bears favourable comparison with the expenditure of the principal electric companies, and testifies to the zeal and ability which has

* This is a low estimate, as experience proves that each 16-c.p. lamp installed will yield an income of £1 per annum at 6d. per unit; and as 13 000 lamps installed represents in this district 10,000 simultaneously at work, the income may be expected to reach £13,000, or even more, per annum, and this without taking any account of the consumption for motive power during the times of light load.

† The actual sum due to the National Bank, as shown by the pass-book of the electricity department, is only £18,300. 1s. 11d., but the balance of £21,854. 3s. 4d. includes sums due, and to become due for extensions in hand, but not completed.

been exhibited by the committee and their advisers in carrying out this important work.

It will be necessary to construct before long two other installations, and I do not doubt that before many years are over the capital invested must reach half a million of money, but it is of no consequence what is spent if a good profit can be shown upon the outlay. The gas company receive from St. Pancras an income of about £50,000 a year, and the capital value of their property in the parish is estimated at about a million and a half sterling.

The cost of electricity, considering the relative amount of light, bears favourable comparison with the cost of gas, there is less risk from fire, and from the point of view of health and cleanliness, electricity is far superior to gas—a point of view which should be considered by the Vestry as the sanitary authority of the parish. In future the cost of electricity will no doubt be reduced through several causes in relation both to its production and distribution. Prof. Robinson reports that one very probable means of diminishing the cost of production will be by adopting a system of what he calls "thermal storage," by which the boilers are worked continuously, and the heat generated during periods of little or no demand is stored up in water heated to a high temperature at high pressure for utilisation at the times of maximum demand.

There is one source of profit that has not developed as rapidly as was expected—that is, the use of electricity for motive power. It is a subject to which the chairman of the committee, as is well known, has devoted much time and attention, and is one upon which I laid much stress in my report to the Vestry made in 1882—10 years ago. When recently it was determined to reduce the price of current for day supply, it was naturally expected that a considerable demand for motive power would arise; but it is to be regretted that, as yet, the advantages offered are not realised by the many small manufacturers to whom this would certainly be a boon. Recently, our resident engineer, Mr. Baron, has developed a suggestion of the chairman's for the provision of a "day switch," which it is hoped will give an impetus to the demand for power, as well as for lighting basements and places where the constant use of gas is injurious.

ECONOMIC POSSIBILITIES OF THE GENERATION OF E.M.F. IN THE COALFIELDS, AND ITS APPLICATION TO INDUSTRIAL CENTRES.*

BY B. H. THWAITE, C.E.

(Continued from page 616.)

The Metropolitan Scheme for the Transmission of Electrical Power generated in the South Yorkshire Coalfields. James Swinburne and B. H. Thwaite.

Description of the Electrical Portion.

Generating Station (see Fig. 1). The motive power will be supplied by 36 gas engines, each one capable of developing 300 b.h.p. It may be advisable at some future time to adopt larger power engines than these, but as we know that gas engines of this size can now be made, it is not requisite to discuss the desirability of employing larger sizes for the present. Larger engines will, however, cost less in proportion to power, be more economic, and will be superior in many ways, so it will be so much the better if we can adopt them instead.† The power will be converted by 18 alternating current generators, each of which will be coupled direct to two gas engines, so that there will be neither belts nor rope gearing. In order to secure a higher and more regular condition of speed than that of a 300 horse gas engine, both the armature and field magnets will revolve in opposite directions. The armature will be driven by one engine, and the field by the other.

The dynamo-electric generating machines will be separately excited by three direct constant current electric machines, coupled in series and driven direct by gas engines. Of these two will be able to excite the whole of the alternators, and the third will be ready as a spare one. The field magnets of the alternators will also be excited in series, so that their excitations, if it varies at all, varies simultaneously in all the machines. This will make it easier to secure a perfect condition of parallel running. In the daytime only one exciting dynamo will be run, and the other will be put into circuit as the load increases and more alternators are required. The independent adjustment of the excitation of the individual alternators will be effected by shunting the field magnets. This adjustment will be made once for all. The arrangement of the exciting circuits is to obviate the necessity of regulating the excitation which otherwise would arise when a cold machine is put in parallel with others whose fields have had time to become warm. The field magnets will not be wound with a single circuit in the usual way, but will have two circuits which are normally used in parallel. This allows the field magnets, which have a large self induction, to be coupled into the same exciting circuit without causing a spark when the switch in series to it is opened. On starting, one of the field circuits is short circuited on itself, and the exciting current is started in the other. It causes a momentary current in the closed circuit instead of making an arc at the switch. This dies away almost instantly, and the second circuit is then opened and put in parallel with the first.

The alternators will give 500 volts and 1,000 amperes each, as a lower pressure would make the switchboard cumbrous and expensive, and a dangerous tension is to be avoided in a station as far as possible. The alternating system will be designed for single currents, and both the armatures and fields will be laminated to secure perfect control, when the machines are in parallel, in spite of the throb of the gas engines.

The switchboard will have two omnibus bars and two single 1,000-ampere switches for each dynamo, and the gear for controlling the excitation and the high pressure circuits. To start a dynamo to the circuit the switches short circuiting its field are opened as already described; its field is then excited to the [illegible] extent, the engines are then run at the normal speed, and one of the switches is closed, so that there is one pole to one omnibus bar. The other switch is now closed through a resistance which permits a large enough current to bring the dynamo into step without any excessive strain. The second switch is then closed, and the machine is not only in parallel, but is taking its adequate share of the work. Each generator has a wattmeter on the switchboard, so that it can be seen at once if a generator is giving its correct output. The gas supplied to the whole of the engines will be regulated by a speed governor, or it may be regulated automatically by mechanism depending on the frequency of the alternating current, or by the hand of the man in charge. The gas for each engine will also be individually regulated. The engineer in charge can thus arrange what portion of the load is to be taken by each engine. This will in practice be settled once for all, as the valve gears of the engines will be so arranged that they take equal volumes of gas and do equal work, the whole of them being under the control of the main station governor. Each engine will have a speed governor as well, but it will be set at a speed above the normal to avoid any chance of running away under any circumstances. The E.M.F. of the station will be controlled by means of the exciting current, so that all the machines will be regulated together. The machine circuits will also have the usual double pole fuses. The omnibus bars will be connected to a bank of large transformers, which will raise the pressure to 30,000 volts. One third of these will be of the open circuit type, their exciting currents being supplied by the capacity current due to the long overhead conductors. The advantage of their higher [illegible] efficiency will thus be secured, and the complication due to the condenser action of the mains will be neutralised. The rest of the transformers, which will be in use for a few hours a day only, will be of the closed circuit type, designed for constant [illegible] loads. The transformers will be oil insulated, or the arrangement introduced by Mr. Kolben, of the Maschinen Fabrik Oerlikon, will be employed.

The transformers will have switches and double pole fuses on both circuits. In cutting a transformer out of circuit, the high pressure switches will first be opened. The fuses will also be arranged so that in case of any short circuit the high pressure circuit is first broken, so that there will be no 30,000 volt arc. The leads will be bare conductors carried overhead on poles. There will be three positive and three negative leads, an [illegible] pressure of 30,000 volts being used. The middle of the circuit will not be earthed at the stations, but electrostatic [illegible] will be arranged to alarm if the middle of the circuit varies from the potential of the earth. In the case of a partial earth on any conductor, that conductor will be instantly earthed [illegible] and cut out of circuit at both ends. The positive and negative wires will be arranged so as to be the same height. There will thus be no capacity currents induced which might affect telephone trunk lines.

The overhead conductors will be carried on creosoted wooden poles at a height of 30ft. from the ground at lowest point in summer. Oil insulators will be used. At short distances along the lines, lightning arresters will be arranged on the poles. The brackets for supporting the insulators will be metallically connected to earth by the lightning conductor on each post, so that if there were a leak at one insulator there would be no [illegible] potential along the post, which might be dangerous to anyone touching it. The upper pairs of wires will be arranged further apart than the lower, so that if one is fused by lightning or breaks it will fall clear of the others. The use of the upper pair of wires will be avoided as far as possible during thunderstorms, and [illegible] admit of this more readily they will be smaller than the lower. In addition to the power conductors, telephone wires will be carried on the same poles. There will also be a spare [illegible] wire for locating faults by the loop test. At intervals along the line there will be guard stations. There will be small [illegible] near the line, into which the telephone and testing [illegible] are led. A fault can be located much more accurately from a guard house than from one of the stations, and a man can go and change

* Paper read before the Manchester Association of Engineers.

† Gas engines compound of 1,000 i.h.p. can now be obtained to order.

the insulator at once, and remove anything that may have fallen against the main.

The receiving station will be on the north side of London, and will only contain the step-down transformers and a switchboard. One-third of these transformers will have open circuits, and will have their exciting currents supplied by the capacity of the lines, and the rest will be of the closed-circuit type, as before. They will transform down to 2,000 volts, and in some cases to 5,000 volts. Circuits will be led from this station to the premises of the various electrical supply companies of the metropolis. Those which employ 2,000-volt distribution will substitute a distributing switchboard for their central stations. In cases where the mains are in a net, the connection will be made direct to the mains.

Where separate circuits are preferred, one-to-one transformers will be used to secure insulation, and the ratio will be adjustable if desired. Small direct-current stations will be supplied with alternating currents, and will remove their plant and transform down to the pressure they require. If the engineers cling to direct currents, they can put alternating-current motors down to run their direct-current machines. Their engines, boilers, and batteries will, of course, be no longer necessary. Large direct-current stations that employ feeders can either use alternating currents on the same system, or can have a number of small sub-stations; or they can have feeder transformers manipulated from our station.

It will be best for the existing electrical supply companies to amalgamate with one another and with us, and, in fact, to cease to have any separate existence. The whole of the metropolis can then be worked direct with less expense. This would demand a large capital, though the supply companies will not need engines, boilers, batteries, or dynamos. These are only a small matter. Low-pressure mains demand a great deal of capital. Where mains already exist, new capital need be found only for increasing the electrical supply; and whether amalgamations could be brought about is a financial question only.

The cost of the plant for 10,000 h.p. comes out as follows:

Twenty gas generators	£8,000	
Steam generators	1,500	
Automatic fuel conveyors	1,000	
Electric way motor sidings	1,200	
Liquor tanks	6,200	
Two gasholders	16,800	
Two tanks	15,000	
Dust vessels	500	
Condensers and sulphate of ammonia plant	4,000	
		54,200
Thirty-seven gas engines	31,600	
Eighteen dynamo-electric machines	35,000	
Exciters and engines	2,000	
Transformers	12,000	
Switchboard and gear	3,000	
		83,000
Line, including poles and insulators		80,000
Receiving switchboard	3,000	
Receiving transformers	10,000	
Connecting mains in London	10,000	
		23,000
		£240,200

Besides the cost of the land, which will be a very nominal sum compared with the cost of land near populous centres, and the necessary buildings, there are various contingencies to be met, such as the possible necessity of underground mains across railways. The costs of way-leaves, and perhaps of parliamentary powers, must be faced, so it will be necessary to have a paid-up capital of some £400,000, and in order to make it worth while to carry out this scheme, there must be a prospect of a handsome profit on £400,000 with a maximum output of 10,000 h.p. at the generating station.

Taking the maximum output at 10,000 h.p., or 7,500,000 watts, the maximum power in London will be 5,400,000 watts.

On the assumption that our first power is used for lighting and almost no motors are used, enough lighting can be taken up to utilise 5,000,000 watts during a heavy fog. This corresponds with a low average load throughout the year, and it will probably be safe to assume an average consumption of 1,000,000 watts only.

The loss in the leads varies as the square of the current, so the effective current throughout the year must be taken. It will be necessary to generate about 1,060,000 watts at the station as an average throughout the year. Taking the cost of coal at 4s. 6d. per ton, after deducting the value resulting from the distillation and complete recovery of residuals, this will cost £1,100 per annum.

The cost of power per year may be taken thus:

Coal	£1,100
Oil and sundries	1,000
Labour	1,200
	£3,300

The cost of generating, exclusive of interest, depreciation, and standing charges, thus comes out at less than a tenth of a penny per kilowatt-hour. The selling price may be taken as follows:

Cost of generation	£3,300
Trade expenses	3,300
Depreciation on plant at 5 per cent.	12,500
Interest on capital, making 7½ per cent. dividends	30,000
	£49,100

This amounts to 1·34 penny per kilowatt-hour. It must be remembered that 5 per cent. is a high rate of depreciation in a case where an average of six-sevenths of the machinery is idle. 1·34 penny per kilowatt-hour is the selling price to the local supply companies. They have to add the depreciation on their transformers and distributing mains and motors, and the interest on the capital invested in them, and the cost of collecting small accounts. As the prices in London vary from 6d. to 8d. per kilowatt-hour, there is obviously an ample margin. We are not so much concerned with what the companies charge their customers as with what they will pay us. It costs them at present more than 1·34d. per kilowatt-hour for coal, oil, and labour, without taking depreciation, trade expenses, and profits into account. It would therefore pay them to take power at considerably over our price, say, 2½d.; and, rather than add more plant in the case of extensions, it would pay them to give even more.

In the above case the worst conditions, those of lighting a city subject to fogs, have been taken. Power taken constantly can be supplied at a much lower rate. Factory engines run about 54 hours a week, and the load factor of a large number of engines can thus be taken at about one-third. We can therefore supply power in large quantities at 0·65d. per horse-power hour, notwithstanding the power load overlapping the maximum lighting supply. Large steam engines can develop power at less than 0·65d. per horse-power hour; but it must be remembered that the power actually used is only a small fraction of the brake horse-power of an engine. In addition to this, an engine and boiler with a varying load works very inefficiently. An engine and boiler in a factory can therefore be replaced by electric motors of very much smaller nominal power, as the elaborate systems of countershafting and belts can be avoided. In addition to this, the efficiency of a motor is fairly high on light loads, and the motors need never run idle.

The Applied Uses of Electric Energy.

The area of application of electric energy is widening like the folds of an opening fan. To merely enumerate the distinctive applied uses would almost fill up the time at our disposal. We will, however, briefly indicate a few of the more salient examples in the arts of metallurgy:

The recovery of gold by electric amalgamation.
The production of aluminium.*
The cheapened production of phosphorus.
Extraction of metals.—Electroplating.
Electro-Fusion.—Welding and annealing of bars.†
Textiles and Dyeing.—Employment in sorting delicate colours, and for the tinctorial art by electrolytic decomposition.
Chemical.—The production of alkalies and chlorine by electrolysis, tanning, and laboratory use.
The Art of War.—Flash signalling, luminous projection, firing repeating guns, and explosive work.
The Safety of Ocean Transit.—Signalling, controlling machinery for propulsion and steering, and ventilation.
Domestic.—For lighting, cooking, boiling, and heating.
Ventilation, knife-cleaning, shoe-brushing, nursery use, sewing-machine driving, and for laundry work.
Agriculture.—Already described.
Engineering.—Partially described.
Commerce.—The transmission and repetition of thoughts and impulses enclosed in speech, by the telegraph, the telephone, and the phonograph.

N.B.—The author has received information from, and now thanks, the following firms and gentlemen and his friend, Mr. James Swinburne: M. Emil Huber, the Maschinen Fabrik Oerlikon, bei Zurich; Herr W. Lahmeyer, of W. Lahmeyer and Co., Frankfort; Mr. C. E. L. Brown, of Messrs. Brown, Boveri, and Co., Baden; The Deutsche Elektricitats Werke zu Sachen, Germany; Mr. Thomas Parker, The Electric Construction Company, Wolverhampton; The Crompton Electric Lighting Company, London; Mr. Chas. Brown, of Bâle; Mr. S. Russell, of Silvertown Cable Works, London; Mr. J. Bailey, The Metropolitan Electric Supply Company, London; and for certain of the lantern slides to Prof. Hele Shaw, Liverpool; Messrs. Ashmore, Benson, Pease, and Co., Limited, Stockton; Messrs. E. P. Allis and Co., Milwaukee, U.S.

From "Currants."—A story is told of a good lady of Slaithwaite who, on a visit to Huddersfield, asked the foreman of the electrical gang at work in the streets, the way the "leet" was made. The foreman replied that electricity was generated by currents. The woman, thinking that "currants" was the word used, straightway went and purchased two pounds of that toothsome commodity. When she found that the electric light could not be made out of the dried fruit she had purchased, she consoled her somewhat ruffled feelings by remarking that "If it ain't bahnd to mak' t' leet, it'll coom in for makkin' t' Kersmas puddin'."

* "Notes on Aluminium and its Production by Electrolysis and Electro-Fusion." By B. H. Thwaite. *Proceedings* Sheffield Metallurgical Society, 1891.

† Messrs. Clark, Chapman, and Co., of Gateshead, have had, in almost hourly use, for the last two years, a complete electric welding plant. They also use the electric energy for their heavy travelling crane.

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ST. PANCRAS.

The St. Pancras authorities, and especially the energetic clerk, Mr. T. Eccleston Gibb, must be congratulated upon the interesting and comprehensive report issued upon the electric lighting scheme. For years municipalities have been waiting for definite and authoritative figures. Now we have them. It is true these figures are those of preliminary work, and of a first year's work, thus giving only a glimpse of what the true returns under normal full working conditions will be; still they are sufficiently clear to enable those who run to read. We have the cost to a London authority of an installation providing for a maximum of thirty thousand 16-c.p. lamps and ninety arc lamps. This amount is £92,246. 14s. 10d.; for the sake of round figures, let us say £95,000. If we may be permitted to say so, this is a very moderate cost. Ignoring the arc lamps, it would amount to about £3 per lamp, and as it is by various authorities estimated that the return per annum of each 16-c.p. lamp is £1, the interest on £3 at 3½ per cent. is something less than 2s. 1d. If the £3 is borrowed for thirty years, repayable in equal instalments, the repayment takes another 2s. These two items give, say, 4s., leaving 16s. to pay all other expenditure. Now we imagine that with a well-regulated central station the total expenditure under normal conditions should not be more than 60 per cent. of the receipts, or 12s.—bringing the grand total to 16s., leaving a balance of 4s. upon each 16-c.p. lamp in favour of revenue, and we trust ultimately in diminution of rates. We have always favoured municipal authorities taking the electric lighting in their own hands, maintaining that the work can be done far more economically and better by this than by any other means. When this is done, however, it is necessary to have a competent engineer—in fact, to have the best experience obtainable. It is a mistake to employ a man with less experience because his terms are ten pounds less. The diminution of one bill by ten pounds may mean the increase of another by a thousand pounds. In the figures we must direct attention to the enormous cost of "trenches" in the metropolitan district. From the accounts trenches cost £13,167, conductors £17,900, and engines and dynamos £18,100. However, all these figures speak for themselves, and we prefer to say a few words upon the future policy of St. Pancras. Advice freely tendered is seldom followed or appreciated. The estimated revenue is £13,000. To pay interest and instalments of borrowed money will take, say, from £6,000 to £6,500 a year. This leaves about 50 per cent for working expenses, which is hardly enough, but with great care the £13,000 income might be found enough for all purposes. It is evident, however, that extensions will rapidly bring into play the £20,000 or so of trench work and mains, expenditure now lying idle. If, as we surmise will be the case, then the returns will be largely increased in proportion to the expenditure, and there should be a good balance left after all expenses had been paid. Counting on this balance is to some people like counting chickens in the egg—

foolish; yet it will come, and for some time might well be used to pay for necessary extensions, instead of charging them to capital. We should like to see municipal bodies charge only the first installation—supposing it to be as large as this—to capital, and for extensions, out of revenue. Repay the capital as agreed upon, and when paid off, use the money thus freed for municipal improvements. The ratepayers, it can easily be shown, would reap benefits both directly and indirectly if this were done.

WOODHOUSE AND RAWSON.

It has been our painful duty in past years to comment on the balance-sheet of this company, but never has the duty been so irksome as now. Previous balance-sheets have shown a good thumping profit. We do not say that in our opinion the profits thus shown were authorised, but certainly the shareholders under the circumstances were not likely to look too closely into the accounts. This year we have an admitted large deficit. We have no sympathy with the shareholders at not getting a dividend. They knew the kind of business carried on, they acquiesced in that kind of business, and they must therefore take the rough with the smooth. As a rule, the shareholder does not care what is done provided you give him his dividend—the larger the better. Most shareholders are bulls or bears—the one set are on the look out for a rise, the other for a fall. The genuine investor is a very small quantity. In previous years we practically exhausted the vocabulary of animadversion upon this company's affairs, and, for once, prophetic utterances have been verified to the letter. If we had had the knowledge of to-day when writing in our issue of October 17, 1890, or November 20, 1891, not a single word of these articles need be altered. What now can be said in favour of the company is rather the question, than what can be said against it. There seems to be a certain *bonâ fide* trading business, though the exact value of the trading is a kind of unknown quantity. Assume, however, that such business results in a net profit of 10 per cent., and that it amounts to £120,000 a year. This would admit a 5 per cent. dividend upon £240,000. No amount of manipulation of the figures of the balance-sheet will, we imagine, show a better state of affairs than those assumed. Of course, the gross profits ought to be sufficiently large to leave this 10 per cent. after all expenses are paid. The capital of the company is close upon £622,000, against £382,000 of which, if a 5 per cent. dividend is to be earned, there is no trading business to earn it. We take it, then, that this amount—viz., £382,000—is the portion of the capital which has been created and is used for company promotion or for speculative purposes. It may be said, however, that a part has been used to commence branches and businesses that as yet have been carried on at a loss, and which may eventually realise a profit. A careful consideration of figures past and present lead us to the conclusion that £240,000 is an ample capital for the trading and manufacturing business concerned.

CORRESPONDENCE.

"One man's word is no man's word.
Justice needs that both be heard.

MULTIPHASE TRANSMISSION OF POWER.

SIR,—I have read with great interest the valuable paper presented by Mr. B. H. Thwaite to the Manchester Association of Engineers.

Although this communication is still "to be continued" in your esteemed journal, no mention has been made up to date of the fact that the Lauffen Frankfort power-transmission plant, as well as the more recent but commercial installation at Heilbronn using the multiphase or "Drehstrom" system, have been the joint production of the Allgemeine Elektricitäts Gesellschaft and the Oerlikon Works. I beg, herewith to call attention to this, to us important, fact that the great Berlin firm—the Allgemeine Elektricitäts Gesellschaft—which we represent in Great Britain—has very materially contributed scientifically and commercially to the development and success of the multiphase generation, transmission, and distribution of electrical energy.—Yours, etc.,

F. T. EGGERS, General Manager.

Electrical Company,
122 and 124, Charing Cross-road, W.C., Dec. 19, 1892.

CHELTENHAM.

[The following is Mr. Hall's report referred to in our last issue, and should be read in conjunction with that of Prof. Ayrton previously given.—ED. *E. E.*]

Mr. Hall's Report.—In accordance with your instructions of the 24th February, 1891, I beg to report on the best system to be adopted for introducing the electric light for the purposes of public and private lighting in Cheltenham; under the provisions of the Cheltenham Electric Lighting Order, 1892. Apart from the so-called systems of individuals or companies, electrical distribution may be divided into two great systems or divisions, which are usually known as alternating and continuous; both are regularly used in England and on the Continent, and each does good service under the conditions for which it is adopted—probably the best English examples of stations on the alternating system are Deptford with Ferranti machines, and the City of London with Mordey machines. It is now generally recognised that the field for low-tension continuous currents is confined to supplying within a very small radius from the works; and where, in such districts as St. James's and Pall Mall, the area is small and the demand large, there can be no question as to which is the right policy. Where the distances are very great and the amount to be supplied at any one point very small, the low tension must give way to high tension, and the simplicity of the alternating transformer, which will reduce the high tension in the mains to low pressure in the consumers' wires, renders the use of high-tension alternating currents most desirable. At the same time, it is right to say that an installation is being erected at Oxford, in which it is intended to use high-tension continuous currents and to transform down to low tension near the consumers, but this involves the use of moving machines, admirable in themselves, but having the weakness of all moving machinery unless attended to at all times, the cost of which practically prohibits it. Alternating currents have, no doubt, some disadvantages, the principal of which are that secondary batteries cannot be used either for receiving or discharging, and up to the present time small alternating motors have not been quite so successful as those constructed for continuous currents, but the demand in Cheltenham for small motors is not likely to be on a sufficient scale to warrant the setting aside of the more economical system to provide them, and the more, that there are several very promising machines now being offered, though not yet commercially obtainable. The extent of area of supply, within which mains must be laid within two years, consists of the following streets: High-street, Ambrose-street, Clarence street, Manchester-street, road to Great Western Railway Station, Colonnade, Promenade, Queen's-circus, road from Queen's-circus to Westal-green, Montpellier-walk, Pittville-street, Portland-street, Evesham-road, and Winchcomb-street to Pittville Gates, with extensions in such directions as may be demanded by householders upon their complying with sections 21 and 22 of the order. These extensions may and probably will be required along Lansdown-road to the park, up the Bath-road to the neighbourhood of the college, to Bays-hill and to Pittville; but it is impossible to say in advance in which direction the extensions will take place. The reasons for choice of a system therefore resolve themselves in (*a*) Which is the most economical in capital outlay? (*b*) Which lends itself most readily to extension without interference with the works first put down? (*c*) Which shows most economy of maintenance? and (*d*) Which gives the greatest convenience of distribution? On all points except economy of maintenance, high-tension alternating currents have the advantage, and in this matter it is most difficult to institute comparisons where probably the personal equation of management is frequently the largest

factor. The site selected is adjoining the destructor, the reasons for the choice being The site is in hand. The chimney stack is built. There is 60 h.p. to 70 h.p. available at all times. Its proximity to the Midland Railway will enable coal to be delivered to the boiler-house without the cost of carting and unloading. Reduction of standing charges, such as weigh-clerk, timekeeper, and superintendent, all of which would be shared with the existing works. Abundance of water, the avoidance of smoke and noise in the town. The current will be generated at the central station at a pressure of 2,000 volts, and conveyed along highly insulated concentric cables, each consisting of 19 No. 16 copper wires, which will transmit all the current for public lighting, and for about 5,400 16-c.p. and 8-c.p. lamps to St. George's square, along Ambrose street and Manchester street, to sub-station No. 1, from St. George's square to the sub-stations shown at the corner of the Colonnade, at Cambray, and near the new club, in highly insulated concentric cables proportionate to the energy to be transmitted, drawn into tubes formed of paper and treated with ozokerit, and embedded in the concrete walls of the conduit which carries the low pressure mains. A specimen of the paper tubes accompanies this report. At the sub-stations transformers will be placed, the number of which will be increased from time to time as further demands for light arise. They will be worked in the proportion of 20 to 1, thus reducing the pressure in the distributing mains to 100 volts. The low pressure system will commence at St. George's square, and in the first instance will be extended along High street to Bath road, and from High street along the Colonnade to Queen's circus, and from sub-station No. 1 along Clarence street to High street. It will consist of four bare copper strips each 1¼in. × ⅛in., and two each ⅝in. × ⅛in., carried upon porcelain insulators in a cement conduit 13½in. in width, and arranged upon the three-wire system. By increasing the number of transformers it will be possible to supply any quantity of current that may be required in the streets named. In the wall of the same conduit it is proposed to place paper tubes, into which will be drawn high pressure concentric cables, the lamps being arranged for lighting in series so as to reduce the cost of the mains, all the street lighting being controlled from the sub-station No. 3 at the junction of the Colonnade and High street. It will be necessary to exercise great care in arranging the height and distance apart of arc lamps in the Promenade, so as to obtain a brilliant effect with an equal illumination in all parts, and they should be suspended over the centre of the roadway, as it is only at that point that a sufficient height can be obtained without obstruction from the branches of the trees. In High street and similar places, where the shops and houses are built up to the line of the pavement, the lamps would be slung from chains, which may be stretched across the street from building to building, thus avoiding the obstruction caused by the ordinary lamp pillars, and placing the lamp in its best position. In each street the wires will be arranged in two circuits, one of which will supply about two-thirds of the whole number of lamps, and the other about one-third, the one-third circuit including the lamps at the intersection of cross streets, and any other which it may be necessary to keep alight all night, the two-thirds circuit supplying all those lamps which may be extinguished at, say, 11 or 11.15 o'clock p.m. The lamps in each circuit will be supplied from a separate transformer, which will be switched off and on with the light, thus obtaining the light in the most economical manner and with a smaller loss of energy than by any other system, the transformer, being designed to suit a known constant load, can be adapted to work with the maximum efficiency at all times. Should it be desired at any time to add incandescent lamps over the footways for special occasions, they can be supplied from the low pressure system in the same manner as the private houses are supplied along any part of the streets in which such low pressure system is provided. With respect to the means of supporting the lamps in the Promenade, the width to the centre of the roadway (25ft.) is much too great for any satisfactory form of cantilever to be used. The choice therefore will rest between centre pillars, a light girder or arch, and a chain. Of these, centre pillars, such as are used in Euston and Tottenham Court roads, would entirely destroy the character of the avenue, and be most undesirable; arches, if below the general line of the trees, would tend to be obtrusive, and would be somewhat suggestive of a large railway station; girders, if of open design, say single triangulation, and placed very high among the branches, might not be noticeable during the day; chains, from lofty iron posts, would be least objectionable during the daylight, and this system would readily lend itself to an alteration of the level of the lamps to suit the varying conditions of the surrounding foliage. Provision has been made for separate transformers for the assembly rooms and theatre, in case they decide to take current instead of running their own machinery. The installation at the central station will consist of two sets of engines and dynamos complete, each of which will give an output of 40,000 watts, and one set of engine and dynamo complete to give an output of 100,000 watts, a maximum of 180,000 watts, or 48,000 candles; the buildings are designed for continuous extension, and it is proposed to adopt the 100,000 watts set as the unit, adding engines and dynamos of this size as the demand increases. As soon as the portion already described is in working order it is intended to proceed with the extensions along the streets named, being the second part of Schedule A of the order, providing with these extensions another unit at the central station. The boilers are proposed to be: One existing tubular boiler in the destructor, 12ft. by 7ft. 6in.; one additional tubular boiler 20ft. by 7ft. 6in., to be worked at a pressure of 80lb. per square inch, and heated by the destructor fires. In the boiler house after the commencement two *Lancashire* boilers each 20ft. by 6ft. 6in. diameter with Galloway tubes, to be worked at 120lb. per square inch, and additional boilers of the same [illegible] to be added as the demand for light arises. The cost of the [illegible] stations, sub-stations, and high and low tension mains, and [illegible] lamps in the High street from Tewkesbury road Bridge [illegible] Bath road, Ambrose street, Manchester street, [illegible] Colonnade, Promenade, Queen's circus, and Montpellier [illegible] the Gordon lamp, and Winchcomb street will be about [illegible]. The extension of the high tension and the low tension [illegible] the streets, detailed in Schedule A of the order with one [illegible] unit complete at the central station, but exclusive of lamp [illegible] and lamps for street lighting, will be about £6,400 ext[illegible] the machinery will have a maximum output of 280,000 [illegible] which is equal to 9,000 8-c.p. lamps or, exclusive of street [illegible] ing, of 7,100 8-c.p. power lamps available for sale. [illegible] demand reaches 180,000 watts an additional unit should be [illegible] together with an additional boiler, and in like proportion [illegible] output of 600,000 watts is reached, so as at all times [illegible] reserve of at least one complete unit and one boiler; after [illegible] have been reached, the reserve should be two complete units. The conduits are all designed so as to be of sufficient size for [illegible] and the estimates are based upon the use of the highest [illegible] of material so as to avoid as far as possible recurring [illegible] repairs and the subsequent interruption of traffic. The [illegible] distributing mains, and transformers are sufficient to [illegible] 1,200 lamps each of 16-c.p. between New street and the [illegible] nade, 4,500 lamps between the Colonnade and Cambray [illegible] lamps between Cambray and the Bath road, 3,800 in the [illegible] menade to the New Club, and 1,500 between the New Club [illegible] the Queen's Hotel, together with all that can be [illegible] Clarence street, in addition to the theatre and assembl[illegible] The advantages of dealing with the question in the [illegible] described are that The capital involved is limited, [illegible] soon whether there is a sufficient demand for the elec[illegible] The necessary extensions can be made as the demand [illegible] arises. No plant is purchased until there is a reasona[illegible] bability that it can be immediately set to work to [illegible] thus reducing the possibility of loss to a minimum. [illegible] variety of work to be done, it will be desirable to div[illegible] number of sections, some of which can be best carried [illegible] tract, and others by purchasing the materials and plac[illegible] position by the Corporation workmen. Probably the [illegible] factory divisions will be: Central station buildings, [illegible] engines, dynamos, transformers and switchboards, [illegible] boilers, purchase from a maker of repute; conduit and [illegible] Corporation workmen; high tension mains laid complete [illegible] copper strip, contract; copper strip, fixing, Corporat[illegible] lamp pillars, contract; lamp pillars, wiring and fixing, Corporation workmen; lamps, purchase from makers.

Cost of Running (Preliminary, say, First Year.)

Fuel, 575 tons at 7s. 6d.	£215 0 0	Arcs, 38 at £15	£[illegible]
Oil and waste	65 0 0	66,720 Board of Trade units at 6d.	1,6[illegible]
Carbons for 38 lamps at £3	114 0 0	Balance (adverse)	[illegible]
Labour and supervision	1,018 0 0		
Depreciation, repairs, and interest	1,174 16 6		
	£2,586 16 6		£2,5[illegible]

Cost of Running (after Extensions, say, Second Year.)

Fuel	£350	Arcs, 38 at £15	£5[illegible]
Oil and waste	80	174,000 Board of Trade units at 6d.	[illegible]
Carbons for 38 lamps, at £3	114		
Labour and supervision	1,452		
Depreciation, repairs, and interest	1,790		
Balance (profit)	1,144		
	£4,920		£4,9[illegible]

The street lamps are assumed to be, 22 in the Promenade, [illegible] the High street between St. George's square and the [illegible] one in Clarence street, and one in the triangle at St. [illegible] square; and the cost will be practically the same as gas [illegible] large lamps now used in High street and Promenade. [illegible] balance sheets it is evident that the preliminary [illegible] alone will result in a deficiency of £318 1s. 6d. per [illegible] that as soon as a second unit is added, the earning [illegible] sufficient to cover not only the extra cost of running, but [illegible] interest on the extensions, and leave a profit equal to [illegible] 5 per cent. on the capital, or you will be able to reduce [illegible] to 5d. per Board of Trade unit, which will be equal to [illegible] about 3s. 4d. per 1,000ft., and any further extensions [illegible] central station plant will enable you to still further reduce the [illegible]

COMPANIES' MEETINGS.

WOODHOUSE AND RAWSON UNITED, LIMITED

Under the presidency of Sir Rawson Rawson the third [illegible] general meeting of the above Company was held yesterday at [illegible]

Cannon-street Hotel, in the presence of a large number of shareholders. After the Secretary had read the notice calling for the meeting,

The **Chairman**, in moving the adoption of the report (which we give in another column), said that the occasion of his addressing them that day was important to the future of the Company. Following the precedent of Lord Aberdare, he had committed to paper what he had to say. He remarked that he would have to deal in detail with some matters. It was his wish and that of his colleagues to give the shareholders the fullest information on all matters concerning the Company, and to place them in a position to correctly estimate their position and prospects, and form a judgment as to the wisest course now to be followed. He commenced by analysing the losses during the past year, in order to show them the causes from which they had arisen, and to satisfy them, as he hoped to do, that those causes were exceptional and would not recur. The first of those, as shown in the profit and loss account, was that relating to the lamp settlement action amounting to £14,472. They were aware that this Company was prevented by the resolution of the action of the Edison and Swan Company from manufacturing and selling incandescent lamps in the United Kingdom. As a result, they were prevented from utilising their valuable lamp patents, which had made the reputation of the Woodhouse and Rawson lamp. Subsequent to that action, the Company entered into arrangements with the British Electric Light Company to work under the license obtained from the Edison and Swan Company. Owing, however, to a technical and legal point, they found themselves in a position in which there was no alternative but to give up the manufacture of lamps, or run the risk of heavy damages at the suit of the Edison and Swan Company. By those means they were deprived of one of the sources of profit from the beginning. In order to settle the action of the Edison and Swan Company, they had to incur a heavy loss, the major portion of which was due to writing down the stock and plant in the department. Next November, however, when the lamp patents expired, they expected to resume the manufacture with the advantage of the reputation which they had already established. In the meantime they hoped to dispose of a considerable portion of their stock at a rate above even that at which it was stated in their stock-sheet. The next item was that at Kidsgrove, amounting to £17,000 odd, they had lost on contracts taken over from the vendors, and works taken by them whilst in the service of the Company; also the debts incurred by the failure of the vendors' firm. In the matter of the Kidsgrove purchase the Directors considered themselves justified in relying upon the judgment of their then manager. The reports which he had made to the Board spoke in unqualified terms of the advantageous character of the purchase, of the excellent business being done, and of the opportunities which the acquisition of the works would confer for developing the other business of the Company. At that time it was absolutely necessary that they should manufacture certain classes of electrical apparatus and machinery which they had not hitherto undertaken. They had lost customers through not being makers of some kinds of apparatus. Under the present management the contracts undertaken, with very few exceptions, had been profitable, a large amount of business had been taken up and had been carried out successfully. As their manager informed them, orders to the extent of nearly £50,000 had been offered to them, and which they could have undertaken if they had had the necessary capital. The work done had added to the reputation of the Company for good work. The third item was the loss on the trading and depreciation, amounting to £37,000. As far as they could make out, nearly £30,000 of that might be said to be depreciation, and not actual trading loss. A portion of the loss was due partly to agencies which had since been closed as unprofitable, and the initial expenses in forming new branches, several of which had only been in operation for four or five months, and they were now beginning to pay their way. The most prominent was at Johannesburg, where most lucrative prices were being obtained. A great deal of the loss on trading was due to their Cadby Hall factory, which they proposed to close after Christmas for a time, and the expenses there would be reduced to a very small item. Standing charges which had amounted to £6,000 a year, would then be converted into a profit of about £600 per annum. The sum of £5,650, which was the next item, for depreciation of patents, was the proportion which they had decided to write off each year. They had acquired over 20 patents last year, of more or less value, and at a mere nominal sum, or on the terms of sharing a small portion of the profit with the inventors. That was the method generally adopted. With regard to the Epstein patents, it had been shown to their experts that the accumulator made under them was destined to prove one of the most valuable inventions of the day. He emphasised this by referring to the use of the batteries at Birmingham, and by the fact that one of the largest firms had undertaken to supply motors, etc., and the Epstein Company the accumulators, and there was little question that a majority of the tramway companies would adopt the Epstein system. The reason why the Company did not work all its patents itself was because a large amount of capital was required, and the only way of realising a profit on a very valuable invention, worth £100,000 to £200,000, was by selling it to a company. With reference to the depreciation of securities, what was only worth £1 to-day might next year be valued at £2, £3, or £4, everything depending upon the market value. Their securities had not been bought, but were held in companies brought out by their assistance. The Chairman then considered the special report of the auditors, and which was mentioned in the report on the balance-sheet. Several questions raised by the auditors at the date of their signature on December 12 had since been cleared up to their satisfaction. That special report explained that the reason for the books not having been balanced was because the Directors had not employed a sufficiently competent bookkeeper, but at present they were in charge of an experienced man. Regarding the vouchers which still remained to be produced, the Chairman said that the Board expected them to be shortly forthcoming, and that the amount would not be inconsiderable. As far as the repayment of the guarantee, and which had the sanction of a special meeting, he read a paragraph about it from the original prospectus. It had been stated in last year's report that the prospects of the Company were extremely promising. Well, they had then secured the contract for the electric lighting of the Champs Elysées in Paris. Half the capital had been subscribed there, and if it had not been for the great depression, the other half would have been raised here. As a result, the opportunity of making a profit over that concession had been lost. Other matters were the Oncken Company and the Epstein patents. In the former, owing to the small amount of capital subscribed, they had to take their profit in shares instead of in cash, whilst in the case of the latter they had considered it prudent to postpone bringing it out. The Directors had viewed with considerable anxiety the probability of finding £75,000 in cash to repay the vendor company on the 1st of July last. They succeeded in compromising the scheme by paying £12,000 in cash and £51,000 in debenture stock, instead of £75,000. The Company had considerably reduced its expenses, and by the end of the year all the sources of loss would be eliminated. He hoped during the coming year to obtain a fair profit, but for that purpose it was necessary to pay off credits and have a balance for working capital. The sum required, though not immediately, was £60,000, and they proposed to raise that by mortgaging their free investments, amounting to £70,000, and the stock-in-trade and merchandise, which amounted at the date of the balance-sheet to £10,000. The rate of interest to be paid was high—namely, 10 per cent.—but it was only a temporary loan for 12 months, and would be issued *pro râta* to the shareholders and debenture holders. The balance would enable them to undertake profitable contracts, which were offered to them to the extent of from £30,000 to £40,000 as soon as they had the necessary capital. If it should fall below £60,000, the loan would be immediately repelled. Counsel had informed them that they had the power of creating a specific charge upon the Company's assets, with the exception of the freehold and leasehold premises, which were already mortgaged. The Directors invited the shareholders to support them in that direction, and they thought they were justified in so doing, seeing that the branches and central control were in thoroughly competent hands. He then moved the adoption of the report and accounts.

Sir John Stokes seconded the motion.

Dr. W. Squire did not think it was likely that they could raise additional capital until something more was known about the actual business of the Company, and in order to raise the question he proposed, in no hostile disposition, to move that the report be not adopted, and that a committee of investigation of the shareholders should be formed and report upon the affairs of the Company. He disclaimed any imputations or suggestions in making these remarks. Since the first two years of the Company's existence, its condition had changed. Formerly they received dividends; now they came to a loss of £120,000, and it was difficult to offer any explanation for the difference. He noticed that industrial undertakings had the knack of being exceedingly prosperous at the beginning and then they collapsed, and that was always the case when the whole of the shares at the commencement had not been taken up by the public. They could make their profit for a year or two as much as they liked; put down the stock, goodwill, patents, and generally unsaleable securities for any amount desired. The accountant was unable to check the figures, he having to take them as stated to him, and the result was a magnificent balance-sheet certified by well-known accountants. The accountant could, however, do one thing—he could insist that the stock from one year should be debited to the second year. The ultimate result was a heavy loss.

A long and exciting discussion then followed, and among those participating were **Mr. Battye, Messrs. Bacon, Lockwood, Griffith,** and others.

Mr. F. L. Rawson also addressed the meeting, as did also **Mr. Pope** and **Mr. Statchbury** (manager of the Company).

Ultimately **Sir Rawson Rawson** read the following amendment, proposed by **Dr. W. Squire**, and seconded by **Mr. Bacon**: "That a committee of consultation, consisting of five of the principal shareholders, with power to add to their number, be appointed to confer with the Directors as to the present position and future prospects of the Company, and report to the shareholders at the earliest possible date, and also that the balance-sheet and statement of affairs from August 1 to December 31, and submitted to the special meeting to be held as early as possible; further, that the consideration and the adoption of the report be deferred until the report of the committee be 1892, be prepared under the supervision of the committee received."

This was put to the meeting and carried unanimously. The committee formed comprised Messrs. Pilling, Whateley, Griffith, and Bacon, Dr. Squire, and General Fyfe.

Sir Rawson Rawson moved that the Directors be authorised to raise a sum not exceeding £20,000 on the security of the floating assets of the Company, and that for this purpose the borrowing

powers of the Directors, according to the articles of association, be increased from £250,000 to £265,000.

This was seconded by **Sir John Stokes**, and was adopted.

The existing Directors and auditors were then re-elected, and the meeting adjourned as set forth in the amendment.

THE ELECTRIC CONSTRUCTION CORPORATION, LIMITED.

Under the presidency of Sir Daniel Cooper, Bart., chairman of the Company, the fourth ordinary general meeting of the Electric Construction Corporation, Limited, was held on the 16th inst. at the Cannon-street Hotel, in the presence of a large number of shareholders. After the secretary (Mr. W. Samson) had read the notice convening the meeting (the proceedings of which throughout were of an animated nature),

Mr. Dunnill rose and complained of his solicitor, Mr. Wainwright, having been excluded from the gathering, and he wished to put it to the shareholders whether he should not be permitted to be present.

Sir Daniel Cooper said that it was a very unusual thing for a person who was not a shareholder to come in and interfere with the proceedings. The Board would, however, allow Mr. Wainwright to be present.

The **Chairman** then remarked that he was glad to see them all there that day, and he hoped that many of them, after what they heard, would be much better satisfied when they went away than they were when they entered the room. In order that he might not under any impulse say what might be considered a little strong, he had written down what he had to say so that it could be produced against him, and in that way he was sure to be able to answer for what he had said. Three months ago he very reluctantly and at the entreaty of his colleagues undertook the chairmanship of the Corporation, and from that day until then his best endeavours had been directed towards the re-establishing of the credit of the Corporation. He and his colleagues had stuck manfully to the ship, and had obtained for it within a few weeks a position it had never held since the day it commenced work. Since his election as chairman, the time of the Corporation had been a critical one, and the Directors, individually, and collectively, had found money and credit so as to enable them to meet all demands, and to do that they had had to incur responsibilities which he did not think any other board of directors would have done. But they had faith in the soundness of the Corporation, and they thought that the shareholders would appreciate their efforts. The Corporation, when it started, had to make its name like all new companies, and had to obtain work at times under onerous conditions. The profits earned, therefore, should not be gauged from an old-established Company. He instanced the work at Manchester-square station, and near Rathbone-place, the overhead railway at Liverpool, the works at Oxford, and the South Staffordshire tramways. Those important orders, to some extent, gave the Corporation a footing and a name in the trade, and were a guarantee for future orders, of which they had £60,000 to £70,000 in view. When the name of the Corporation was established it would enable it to obtain contracts on more favourable terms. The experience gained during the past three years would enable the Board to guide and manage the business more firmly and economically. As a body the shareholders had not supported the Corporation as they ought to have done in the issue of the preference capital, and the Directors had had to find the means to carry on the Company. Therefore from their practical knowledge, it would be a folly to declare a dividend. They now asked the shareholders to contribute towards the £100,000 second mortgage debentures, and help the Corporation. Mr. Duncan had issued a circular from a sick bed, and he thought that his notions were none of the brightest. He might instance his (Mr. Duncan's) remarks about the Electrical Power Storage, which was taken by the Electric Construction Corporation at a large price. From that day until it was leased to the present company the turnover gradually dwindled, and if it had been continued by the Electric Construction Corporation it would have vanished by this time. On the other hand, managed separately, it had regained its old output in 12 months, and this was increasing—the Corporation was receiving £9,000 a year as a minimum, and as it held the bulk of the shares in the undertaking it practically received all that was made by the Electric Power Storage Company. Sometimes they could not marry two companies. What they wanted was to get electricity in the accumulators and the other in a direct manner, and each business should be kept distinct, so that those who required secondary batteries would go to the Electrical Power Storage Company, and for the other system they could come to them. Mr. Dunnill, the holder of a few shares, had also issued a circular, which he (the chairman) trusted the shareholders would treat respectfully; but he hoped they would not be led away in a scare and destroy their property by statements that could easily be answered. As he had already mentioned, the present Directors had done a great deal in a short time to put the Company on a firm footing; they hoped with new blood to do much more during the year to concentrate the resources of the Company, and to confine the business to its legitimate work; but whilst they were doing that, they must not be harrassed by a committee of investigation, which would only have a disastrous effect upon the business of the Corporation, already seriously injured by the attacks of hostile shareholders. The Directors did, however, not wish to withhold any information from the shareholders who appointed the auditors, Messrs. Brodie, Paterson, and Co., who were most able and painstaking, and who would not pass any transaction which was not strictly correct. He was informed by their legal adviser that Mr. Dunnill's motion was out of order, but, nevertheless, it might not be out of place to state the conclusion which the Directors had arrived at. In the first place, he himself held as large an interest in the Corporation as the whole of the shareholders whose proxies Mr. Dunnill had obtained. He merely mentioned that to show that the Board had a very substantial interest in the property of the Corporation. The Directors had carefully considered the proposal for the appointment of a committee in the resolution embodied in Mr. Dunnill's circular, and they had come to the conclusion that there were very grave objections to a committee. The Directors of the Board, as now constituted, had nothing whatever to conceal, and if they considered their own feelings, they would welcome the appointment of a committee, but they were perfectly satisfied that it would be detrimental to the interests of the Corporation. As an example of this, he mentioned that a foreign contract, which they had had good hopes of securing, had gone beyond the Corporation on a statement made by the gentleman who had its disposal, that the rumours existing concerning the Corporation, and [illegible] as to its inability to carry out the work, had prevented [illegible] offering them the contract. The final settlement of [illegible] which they hoped they had secured was being suspended [illegible] the result of that meeting, possibly waiting to see whether the Corporation was in a position to carry out the contract, the [illegible] of which was about £50,000. But altogether apart from these considerations the Directors could not see that the appointment of a committee, or its report, could carry the weight with the shareholders which would the examination into the affairs of the Corporation which had just been made by the Electric and General Investment Company, and which had no interest in the Corporation. When a loan to the Corporation was required, that company caused an examination to be made of the books and accounts, and an expert reported upon the works. The result was that the Electric and General Investment Company agreed to [illegible] £50,000, which, he might tell them, was absolutely necessary to carry on the business of the Corporation. Surely that fact ought to carry more weight with the shareholders than the report of ten committees. For those reasons the Directors had come to the conclusion that they must resist as most prejudicial the carrying of any such resolution as indicated in Mr. Dunnill's circular. At the same time they would regard the passing of such a resolution as a vote of lack of confidence in themselves. He hoped that he had sufficiently impressed them with the gravity of the issue as affecting the future of the Corporation. As he was suffering from a severe cold, the Vice-Chairman would explain the figures in the balance-sheet. He thought that he was better able to do that than himself. They had had no managing director for some time, and in a large corporation like that it was very difficult to manage unless they had somebody who gave constant attention to the business. Mr. Courtenay, the vice-chairman, had been doing that without any pay, and in that way he had the details more at his fingers' ends than he had, because he (Sir D. Cooper) could not give the time or come to the City as he did. He then moved that the report of the Directors, and the accounts annexed thereto, be received and adopted.

Mr. J. Irving Courtenay (vice-chairman) responded with pleasure to the call of the chairman, who had so gallantly come to the assistance of the Corporation under the trying circumstances with which they were all more or less acquainted. He [illegible] the Corporation owed a deep debt of gratitude for the [illegible] financial support given it in the time of need by Sir Daniel Cooper, who has been loyally aided by the present Directors. He proposed to go through the profit and loss account and balance-sheet, and offer such explanations as might seem necessary. Taking the profit and loss account first, the head office expenses, [illegible] £7,870. 3s. 1d., were less than they were last year by [illegible], which he thought they would agree was a substantial reduction, and the Directors intended to still further reduce those items. The amounts under the head of "special expenses" were very large, but the bulk of them might be deemed to be exceptional, and not likely to occur again. For instance, the chief amount [illegible] allowances on contracts arose in the final settlement of accounts in regard to one important account, namely, that with the Metropolitan Electric Supply Company, Limited. There were questions of vibration and other legal questions [illegible] in the opinion of those who knew the [illegible] the arrangement come to between both companies was a [illegible] one. They were indebted for that friendly arrangement to the kind offices of Sir Henry Mance and Sir [illegible]. Another amount was for [illegible] to the [illegible] Chemical Agency, one of the subsidiary companies, in [illegible] tion of a licence for some of their patents which were [illegible] the proper working of patents which were sold by the [illegible] to the [illegible] Company, Limited. [illegible] Corporation had a very considerable interest in the [illegible] Chemical Agency. The last item of the [illegible] for [illegible] in connection with the [illegible] Corporation was bound to make a good [illegible] tions but following years benefited by [illegible] for new business. The [illegible] patents had been [illegible] account in the past year owing to [illegible] portant case known as the "Lane Fox [illegible]" which, he was glad to say, resulted in [illegible] Lane Fox. This, again, was an [illegible] would be felt in future years. [illegible] items under the head of special expenses might [illegible] chargeable to capital; at any rate, [illegible] revenue of one year [illegible] the Board's action in writing off all these charges [illegible] had the effect of very greatly strengthening the balance-sheet.

Turning now to the balance sheet, they would observe an item of £8,470 for difference between par value of shares sold and amount realised, which they had deducted from the reserve account set apart for that purpose; and that was a convenient opportunity for him to call their attention to the principle the Board had adopted, with the approval of the auditors. That was, not to value the shares they held in subsidiary companies at any other figure than their par value, but to create a large reserve fund as against them, so that when the shares were realised, should there be any deficiency, there would be an ample reserve to meet it. This special reserve was independent of the £18,000 reserve for general purposes, and a further reserve of £10,000 for bad and doubtful debts. The amount of shares held by the Corporation had been the subject of comment, but he asked them to remember that a large proportion of these shares were acquired in payment for various patents sold or licensed by the Corporation. They should, of course, preferred to have got cash, but that was not possible. It became necessary to develop and work the numerous patents owned by the Corporation in some way or other, and on the best terms they could get, and this remark applied also to the provisional orders. For legal and other reasons separate companies had to be formed. They invited people to assist them in forming them, and they hoped that in future these subsidiary companies would be a source of considerable income, the Corporation keeping itself to pushing and developing its manufacturing and contracting business, so far as practicable, upon cash terms only. They would have noted that there was a sum in cash—£3,115. 15s. 9d.—at the London and General Bank, Limited, which was in liquidation, of which £2,000 was on a joint deposit account on behalf of one of the subsidiary companies, as a guarantee fund in connection with patents sold to them. No official statement of the prospects of this liquidation had yet been made, but they were assured that no loss would accrue so far as this deposit was concerned. As stated in the report, the Directors did not propose that any dividend should be paid on the ordinary shares for the past year, but recommended that the dividend, at the rate of 7 per cent. per annum, be paid on the preference shares to the 30th September last, that £30,000 be placed to a suspense account, and that the balance of £26,862. 1s. 5d. be carried forward. The Directors believed that to be the sound course for men of business to take under the existing circumstances, and that the shareholders would approve that policy. The Directors would make every effort to realise some of the shares, and to make the balance of profit and loss account available for dividend purposes as soon as possible; and though the fixed charges were somewhat heavy, he saw no reason, with strict economy, both at Bushbury and at the head office, why a satisfactory dividend should not be regularly earned in the future. Coming to consider the work done at the Bushbury works, he mentioned that the past year had been a very heavy one there. They had turned out an increase in the amount of work in their ordinary business, and had also put down a system of continuous-current high-pressure distribution of electricity for Oxford, and during the exhibition at the Crystal Palace they delivered by the same system about 500 h.p. over a mile into the Crystal Palace from the central station. The Oxford installation, they were informed by Mr. Parker, had proved to be thoroughly efficient and reliable, and it would stand among the first of the installations in this country in the future as a means of supplying energy for lighting and power. They had also carried out the contract for the Liverpool Overhead Railway Company, a new departure in this country, or nearly so, putting down the whole of their power in the electrical portion of the engineering, carriages, and all necessaries for running the line. This line was expected to be in running order about the end of the year. They had manufactured and installed 7½ miles of an overhead system of tramways for the South Staffordshire Tramways Company, Limited, which was shortly to be opened for traffic. This work, he was informed, had been highly praised by the Board of Trade inspector. They would readily understand and appreciate that those contracts had many novel features, and being the first of their kind did not admit of the profit that was to be made when regular business was established, but they might look forward to these being the pioneer enterprises of future great business in that class of work. The works at Bushbury were now thoroughly equipped, and their capacity could be largely extended with great advantage to the Corporation, as the additional charges upon additional business would be very much less in proportion. Mr. Parker told them that he knew of a substantial amount of work in different directions, which he expected would be entrusted to this Corporation to execute. The value of these contracts must not be gauged by the precise cash returns, but must be regarded rather as contained in the valuable advertisement from such important works as the Liverpool Overhead Railroad and the South Staffordshire Tramways. Other important matters worked out by Mr. Parker and his staff were several inventions for the more economical production of zinc, chlorine, and alkalies, and to carry some of these into practical effect the Directors had founded the Electro-Alkali Company. These inventions promised success in their laboratories, and he hoped that Mr. Parker might in a short time be able to report that their commercial application was equally successful. The history of the transaction was this: The alkali patents were in the first instance transferred with other patents to the Electro-Chemical Agency, but when as the result of full experiments Mr. Parker arrived at the opinion that the alkali patents promised to be of great value, it was considered best to put them into a separate company, and they were bought back for preferred shares in the Alkali Company from the Chemical Agency, and they were now the property of the Alkali Company, in which the Electric Construction Corporation had a very large interest. The Chairman had already dealt with the remarks of Mr. W. W. Duncan about the Electrical Power Storage Company, which were, in some important particulars, incorrect. Mr. Duncan was unfortunately not present. The net profit when the Electrical Power Storage business was worked by the Electric Construction Corporation was never what Mr. Duncan stated it was, nor were the annual costs of administration what he stated; they were really about half the amount, because a portion of the account was for 17 months' working, and a large sum was included for carriage etc., which did not belong to administration account. He had explained the figures to Mr. Duncan last autumn, when he remarked that his explanation had knocked the bottom out of his criticisms. He had thought fit to repeat them in the public prints, but the reasons for his whole attack were obvious. Experience had shown that it was practically impossible to run successfully two businesses together which differ so much as do the storage battery and dynamo manufacturing business. The result was, that whereas the business had so seriously fallen off when it was worked by the Electric Construction Corporation, that it had nearly reached the point where no profit could be earned at all, they had, since it has been worked separately, nearly doubled the output and were still increasing it. He thought the shareholders would wish to hear further details from Mr. Parker of the important works he had alluded to, and later on he would ask him to address them. Coming to the important paragraph in the report dealing with the general financial position of the Corporation, he stated at the outset that the problem of how additional capital could be raised on terms which would be satisfactory to the shareholders presented some difficulties on account of the many interests which had to be protected. There was the first mortgage debenture issue at present of £150,000, then there were some preference shares, then came the ordinary shares, and finally there were the founders', whose rights had had to be safeguarded. He was glad, however, to be able to assure them that the scheme which the Electric and General Investment Company, Limited, after a very close study of the whole of the question (with the assistance of the most competent legal advice), had devised for them, was one which protected and preserved the rights of all existing interests, and in this connection it was right perhaps to tell them that they had had an advantage in dealing with the Electric and General Investment Company, Limited, which they should probably not have had if the arrangements had been made with others, by reason of the fact that the Electric and General Investment Company had a special knowledge of this class of industrial undertakings, and they had therefore been better able to appreciate the great potentiality for future work which this Corporation possessed. The problem was as to how £100,000 additional capital could be raised on terms which, while they were sufficiently attractive, were not unduly onerous to the Corporation, and the result was, he felt bound to say, to the satisfaction of the Board. They were raising £100,000 of new capital at a rate of interest at 6 per cent. per annum, which was no higher than the rate of interest paid upon their first mortgage debentures, and the scheme provided for this money to be repaid within a comparatively short period. Of course, it would be obvious that the money could not be raised on such exceedingly favourable terms without offering a bonus, and the form in which this was done was satisfactory both from the point of view of the future of the Corporation and also from that of the shareholders, who had the first right to subscribe the money. The bonus was given in the form of an income bond which was attached to each debenture, and was of a corresponding amount—i.e., the subscriber of every £10 second mortgage debenture received a bonus bond of £10 free of all liability, and this income bond would commence to carry interest from the date on which the debenture was drawn and paid off at par. The rate of interest would be determined for each year by the dividend paid on the ordinary shares of the Corporation for each preceding year. It was, perhaps, desirable that he should explain the procedure a little more fully by giving an example: Assuming that at the end of next year debentures to the amount of, say, £4,000 were paid off; then the income bonds to the amount of £4,000, corresponding to the debentures which had been drawn would commence to carry interest, and they would receive interest for the year 1894 at the same rate as the dividend that might be paid upon the ordinary shares for the year 1893. He had no hesitation in saying that, in his opinion, these debentures with income bonds constituted an exceedingly profitable investment; but he hoped to convince them that the terms were not unduly onerous to the Corporation, because the Board felt that the new capital of £100,000 would of itself produce the amount which was required to pay the interest thereon and to redeem the debentures, and if this expectation was realised it would be seen that the Corporation would obtain the benefit of this increased earning power at the cost of merely the interest paid upon the income bonds. On the other hand, the shareholders who subscribed for those debentures would make an exceedingly good thing, especially those whose bonds were drawn at an early date, because they would receive their principal back with 6 per cent. interest, and would at once rank with the ordinary shareholders for dividend without cost to themselves. This explanation of the scheme would, he thought, make it clear to every shareholder that if he wanted to secure the full benefit of the arrangement for himself, he could do so by taking up his proportionate allotment. In conclusion, it was a great satisfaction to the Directors that the Board had been strengthened by the addition of the Right Hon. David Plunket and Mr. James W. Barclay, both of whom occupied a leading position in the City, and with whose assistance the economies that must be effected in various directions would be judiciously and effectively carried out, and they felt con-

fident that with the support of the shareholders the Corporation could be made to take the first rank among the electrical properties of this country. He then seconded the motion.

Mr Parker, at the request of the Chairman, addressed the meeting. He said that the Vice-Chairman had referred to the work done at Wolverhampton, but he did not propose to criticise his remarks. In that town they had accomplished a very heavy year's work, and as the electrical business was not one which had arrived at a definite stage, the contracts of the year had contained a great deal of novelty. That novelty was necessary to the progress of the business and its prospects in the future, but it had fallen very heavily upon the staff and the factory. They had successfully put down and inaugurated a system of lighting at Oxford by high pressure continuous currents, which was successful and would no doubt be the forerunner of a great deal of business in the future, and they had secured valuable patents upon that system. The Liverpool Overhead Railway was practically completed, being the largest scheme of electrical traction engineering that had yet been attempted. It had called for much experimenting and invention to secure its success, which had been demonstrated. The South Staffordshire tramways contract was also the first of its kind that had been carried out. It was now completed. All those contracts had run through in this year. It would seem in taking the figures of the turnover that the profits had been small upon manufactures turned out at Wolverhampton, but by deducting the goods bought—such as engines, boilers, cables, etc., upon which the profits were small—it would be seen that the profits upon the actual manufactures at Wolverhampton had been good. The ordinary business of the firm had been fairly good throughout the year, and they had in hand at the present one third of last year's manufactures, and also machinery for the central stations at Manchester, Leeds, Coatbridge, and Burnley. They could not say that about Wolverhampton, although the committee had passed the matter. They had also had worked out in the laboratory some features which promised successful application, and upon some of these patents the Directors have decided to institute the Electro-Alkali Company, Limited.

Mr. Dunnill then asked whether the Chairman would allow his resolution to be put to the meeting, but was informed that it was out of order. He then asked why that was the case?

Sir Daniel Cooper said that the notice had been received too late by 24 hours.

Being ruled out of order, **Mr. Dunnill** stated that he would move as an amendment: "That the accounts be not adopted or passed; that the Directors be requested to amend the same by giving particulars of all the shares in subsidiary companies, licenses granted, and patents sold, and the amounts receivable in each case, and from whom; that this meeting be adjourned to enable this to be done, and that fresh accounts be delivered to every shareholder seven days before the adjourned meeting." Mr. Dunnill mentioned that more than a quarter of a million of their capital had been expended, not in manufacturing, but in exploiting companies and dealing in shares. What they wanted to know was what had become of the £250,000 which was represented by shares received or to be received. The Chairman had said that his holding in the Company was equally as large as the total number of proxies which he (the speaker) had obtained. The proxies sent to him, remarked Mr. Dunnill, were 5,389, and he did not know what amount there was at the meeting. Did the Chairman imply that he held more than 5,000 shares in the Corporation? He was of opinion that the shareholders should have an investigation made by gentlemen totally independent of the directorate.

Mr. W. W. Cooke, who seconded the amendment, asked for some information concerning the shares sold, and he expressed the opinion that the Directors should tell them what were the shares held by the Company.

Mr Peachcroft, in opposing the amendment, remarked that personally he was not altogether in accord with the Directors. There were one or two matters which were not satisfactory, but they must not forget that all the shareholders had an interest in common, and that was the benefit of the Company. He thought that the previous speaker was right in saying that they should know something about the shares. He urged the shareholders not to pass the amendment put forward by Mr. Dunnill. Starting on a new year, and having eliminated from the head of the concern many things which were detrimental to the interests of the Corporation, was it wise, he asked them, to undermine that by appointing a committee of investigation? That would mean ruin, and he urged them not to vote for the resolution. With reference to the issue of £100,000 second mortgage debentures, the speaker asked how the Company would stand in the event of a liquidation, and what would be the position of the income bond holders?

Mr. G. Herring (chairman of the Electric and General Investment Company) said that it was not worth while to talk of how they became acquainted. The Board of the Electric Construction Corporation put it roughly something like this: "We want a little straightening up; we think an independent investigation would do us good, and that you are in a position to do that and give us advice." Well, they (the Electric and General Investment Company) laid down certain conditions, which were accepted; previously they had had no business relations or financial dealings. They, therefore, entered into the examination perfectly impartially. It was not possible to make public the report which had been drawn up, but if any shareholder were to read it he would not sell his shares, but would buy more. There had been some mistakes, and the report pointed them out, but with good management and a small outlay the Company should do well. Then, having got the reports and the figures before them, his Board drafted the present scheme, which he explained. He assumed that the £100,000 would produce a 10 per cent. manufacturing profit; if so, that would pay back the £100,000, and the shareholders ought to be gainers thereby. To put the matter more plainly: If the percentage of the £10,000 is earned, it is that £10,000 which pays back the £100,000, and yet the £100,000 still remains in the business. Though the scheme had been commented upon in the newspapers, counsel regarded it as perfectly [illegible]. He thought that success was certain in future with good management, and he advised the Board to let their motto be "More and more and still more economy." To the shareholders he said, "Don't change your Board now just at the time when you are emerging into prosperity."

Mr Millington observed that one of the members of the Board was connected with two or three companies now in liquidation. He thought the shareholders should know the name, as it might influence their votes. He referred to Mr. Dibley, whom he asked whether he would retire from the Board.

Mr Dibley said that he would retire from that or any other Board if there could be in the slightest sense, anything brought against him in connection with his being on the [illegible] General Bank. He could not think of resigning at the [illegible] of one or two persons, as that would be passing a vote [illegible] upon himself as if he had done something wrong. When [illegible] came out in connection with that bank, they would [illegible] that he was not to blame.

Mr Hancock supported some of the remarks made by Mr. Millington.

Dr Drysdale suggested that Mr. Dunnill should withdraw the amendment, as he thought it could not be carried. He was one of the shareholders who had visited the works at Wolverhampton, and he regarded them as the first and most extensive of the kind in this country.

The **Vice-Chairman** considered that it would be very detrimental to the interests of the Corporation to give to the public a list of the shares they held in subsidiary companies. They were, he might mention, held in 10 companies. The shares were [illegible] securities, and no bank would give such information [illegible]. If, however, the shareholders would apply at their offices, they would there be shown the list and be given full particulars in each case.

Mr H. Brown (the solicitor) remarked that the income bonds ranked next to the preference shares in the event of liquidation. In that case the document looked as if the income bonds would exist as well as the second mortgage bonds, though that was not the intention when it was drawn up.

Mr Herring said that when the deed was drawn up it was not the intention that the income bonds, in case of liquidation, should exist together with the second mortgage bonds; they were only to come into existence after the latter had been redeemed. If the matter could be put right, they were anxious that it should be done.

The **Solicitor** was of opinion that the matter could be arranged.

Mr Dunnill then commenced to again read his amendment, but was interrupted by cries of "Withdraw."

The amendment was then put to the meeting, with the result that only five shareholders supported it. It was therefore not carried.

Mr Dunnill then said he should demand a poll, but the **Solicitor** informed him that according to the articles there could be no poll on a question of adjournment of a meeting or the election of a chairman.

The original motion was then put and carried without any dissentients.

Mr Dunnill then demanded a poll on that, but this was objected to by the shareholders generally. This request was however withdrawn on its being shown that the Board had a large majority (7,179) in proxies, and Mr. Peachcroft had 3,000, without including the rest of the meeting.

Mr. James Pender and Mr. John B. Verity, the retiring directors, were separately re-elected, as were also the auditors, Messrs. Brodie, Paterson, and Co.

The assembly came to an end with the usual vote of thanks to the Chairman.

COMPANIES' REPORTS.

WOODHOUSE AND RAWSON UNITED, LIMITED

Annual report of the Directors and statement of accounts for the year ending July 31, 1892.

The Directors, in submitting their report upon the balance-sheet for the year ending July 31, 1892, desire to express their regret that the favourable expectations which they entertained at the commencement of the year, and which they expressed in the last annual report, have not been realised. In common with almost all undertakings connected with electricity, your Company has felt severely the competition of the past year arising through the depression of trade, and this depression has told with especial heaviness on this Company because, acting on the manifest and frequently expressed desire of the shareholders that the [illegible] side of their operations should be developed, the Board has, within the last 18 months, formed branches in the chief centres of electrical enterprise throughout England and the Colonies. Many of these, as, for example, Sydney and Johannesburg, after the initial losses incident to their formation, have developed into promising undertakings, but the benefits likely to be derived from them do not show in the last year's balance-sheet. The result of these developments has been shown by the fact that whereas the

turnover of the industrial portion of the Company's business was, in the first year, £72,258, that of the second year was £126,015, and that of the year just concluded £151,121. On the other hand, the financial portion of the business, which has been repeatedly stated to the shareholders to be the most profitable, has, owing to the financial depression, been almost entirely suspended during the past year. In most of the Company's branches there has been a loss more or less serious, due to a large extent to the unfavourable period which succeeded their formation. Owing to the number of these branches the aggregate of such losses would in any case have proved large, but some are so considerable as to require special notice. The failure of the arrangement for continuing the manufacture of incandescent lamps under the license of the British Electric Lighting Company, obliged the Board during the past year to close down, at any rate for a time, a large portion of their Cadby Hall factory, which had been laid out for the purpose of this part of their business, and has also obliged them, as they are no longer at liberty to sell their lamps in the United Kingdom, to write down the value of their large stock by 75 per cent., the sale price of lamps abroad being only one-fourth of that realised in this country. Their valuable lamp plant has also depreciated largely from the same cause, as it cannot be utilised before the expiration of the Edison and Swan patent in November next. This has been one of the most serious blows to the progress of the Company, but one which may be retrieved when they recover at that date the right of using their valuable patents, which have gained for the Woodhouse and Rawson incandescent lamp an established reputation throughout the world. The Board would point out another serious disappointment in the industrial department during the past year. When the Directors last met the shareholders they had obtained a valuable concession for lighting a large area of the richest part of Paris, and had entered into an agreement whereby they had secured the co-operation of one of the strongest firms in France, who undertook to provide over one-half of the capital required. This would not only have provided a large profit by the sale of the concession, but would have furnished employment for the Company's works for some time to come. But owing to the insuperable difficulty experienced in raising the required balance of capital in this country, the advantages accruing to this Company by the concession were lost. The newly-acquired Kidsgrove and Chiswick works have also been the source of unexpected losses. In the latter case the Board have reduced expenses to a mere nominal amount The loss on the Kidsgrove works was mainly incurred in realising the assets and carrying out the contracts taken over from the vendors. These contracts are now finished, and the works have been placed under capable management; they require only a sufficiency of capital to enable them to carry on an important and profitable business. The remainder of the loss is largely due to the large amount written off for depreciation of stock, which had been increased in the expectation of a demand which, unfortunately, did not arise. The union of Cadby Hall and Manchester under one management has proved most unsatisfactory; the Directors have therefore recently placed the works at Manchester under the separate management of tried and experienced officials of the Company, and are reducing the business at Cadby Hall works to the execution of contracts in hand and actual orders, with a correspondingly large reduction of staff and standing charges. Notwithstanding, however, the serious check received by their industrial department through the causes above mentioned, the Directors consider that the Company would have, to a great extent, recouped itself by the results of its financial enterprise, if the past year had presented any opportunity for launching an industrial company with a reasonable prospect of success. The Oncken Company, which their contract with the patentee obliged them to bring out by the 1st August, yielded only shares as the profit of this Company, and these do not appear in the present balance-sheet. The Epstein accumulator, which was introduced by this Company, has proved a complete success as the most efficient and economical on the market. The Epstein Electric Accumulator Company, in which this Company is so largely interested, has been manufacturing now on a commercial scale for the past six months, and the result of its operations has been to demonstrate that the Epstein accumulator has solved the difficulty of using accumulators for traction purposes. Owing, however, to the general financial position there has been no chance of realising the value of the Epstein patents, but it is expected that this Company will derive large profits from them in the future. The Directors are glad to be able to state that the reputation of the Company is such that inventions of the most valuable description are constantly placed in the Company's hands for development, a share of the patents being given for their services in this respect, and without any money payment on their part. During the last 12 months the Board have given unceasing attention to the reduction of expenses, and they are glad to be able to state that their efforts have been successful. It is anticipated that a considerable further reduction will be effected within the next three months. The Directors have relinquished their fees since last January. The Directors regret to say that Mr Philip Rawson was ordered by his medical adviser to abstain from all business for a time, and resigned his seat on the Board in September last; Sir Edward Thornton also at a recent date requested the Directors to accept his resignation. Your Directors have not filled up the vacancies occasioned by these resignations, for they have felt that it was due to the shareholders that the appointment of Directors should be such as might commend itself not merely to the Directors themselves, but to the general body of shareholders. The auditors, Messrs. Jackson, Pixley, Husey, Browning, and Co., retire in accordance with the articles of association, and offer themselves for re-election.

BALANCE-SHEET, JULY 31, 1892.

Dr.	£	s.	d.	£	s.	d.
Share capital authorised :						
60,000 ordinary shares of £5 each	300,000	0	0			
50,000 preference shares of £5 each	250,000	0	0			
	£550,000	0	0			
Share capital issued :						
Ordinary shares of £5 each :						
37,514 of £3. 15s. called up	140,677	10	0			
17,683 fully paid	88,415	0	0			
	229,092	10	0			
Preference shares of £5 each :						
41,068 fully paid	205,340	0	0			
	434,432	10	0			
Less due on calls	7,400	17	6			
				427,031	12	6
Debenture stock, 5½ per cent., £118,187 ; less held as collateral security, £19,625	98,562	0	0			
Mortgage debenture bonds, 6 per cent.	65,500	0	0			
	164,062	0	0			
Less outstanding	50	0	0			
				164,012	0	0
Pension fund				1,565	0	0
Bad debts, reserve				2,433	1	8
Sundry creditors—Secured	22,006	7	8			
Unsecured	24,819	15	3			
Bills payable	12,488	5	8			
				59,314	8	7
				£654,356	2	9

Cr.	£	s.	d.	£	s.	d.
Freehold premises: Cadby Hall, London ; Union Foundry, Kidsgrove	79,309	12	3			
Less mortgages thereon	23,500	0	0			
				45,809	12	3
Leasehold premises in London and elsewhere				2,528	16	7
Plant, machinery, and tools at Cadby Hall, less depreciation ; Chiswick, Kidsgrove, and Manchester, per valuation				37,554	2	1
Stock (finished and unfinished) and merchandise at works, depôts, warehouses, and branches, per valuation	99,533	8	4			
Goods in transit	1,379	17	10			
Expenditure on contracts in hand.	22,186	13	3			
				123,119	19	5
Sundry investments				101,847	5	0
Furniture and fittings				2,742	19	8
Sundry debtors	73,278	12	4			
Bills receivable	323	14	6			
				73,602	6	10
Goodwill				99,263	8	7
Moiety special expenditure on advertising, repayable by instalments				5,669	0	2
Patents, patent rights, etc.				73,450	18	1
Cash at bankers and in hand				2,033	16	8
Loss				86,734	3	10
				£654,356	2	9

PROFIT AND LOSS ACCOUNT YEAR ENDING JULY 31, 1892.

Dr.	£	s.	d.	£	s.	d.
Salaries	7,764	8	0			
Printing and stationery	1,030	13	3			
Postages and telegrams	886	18	2			
Legal expenses	1,300	8	6			
Travelling expenses	305	9	0			
Directors' fees, £2,000, less amount waived, £1,137. 10s.	862	10	0			
Patent fees	862	8	1			
Rent, rates, insurance, etc.	2,660	6	9			
Royalties	1,954	2	10			
Bad debts, £3,549. 17s. 9d., less reserve £2,600	949	17	9			
Bad debt reserve	1,773	15	10			
				20,350	16	2
Advertising	5,688	0	8			
Catalogues	761	12	0			
Exhibition expenses	1,766	5	1			
				8,215	17	9
Debenture interest				9,350	18	2
Loss on lamp settlement and action	14,472	11	3			
Loss at Kidsgrove	17,784	6	4			
Loss on trading and depreciation of stock, plant, and tools	37,274	3	7			
				69,531	1	2
Depreciation on patents	5,650	1	4			
Depreciation on investments	26,012	10	0			
				31,662	11	4
				£139,111	6	7

Cr	£	s.	d.	£	s.	d.
Net profit at July 31, 1891	51,439	4	5			
Loss appropriated to pay dividend	43,408	16	10			
	8,032	7	7			
Reserve fund	35,000	0	0			
Brought forward from last year	——	——		43,030	7	7
Interest on loans and investments				7,554	18	8
Balance of discount account				379	10	0
Premiums transfer fees, etc.				1,412	6	6
Balance i.e., loss	129,764	11	5			
Less brought forward as above	43,030	7	7			
				86,734	3	10
				£139,111	6	7

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY, LIMITED.

Directors: Grosvenor Talbot, Southfield, Burley, Leeds (chairman); George Henry Crowther, civil engineer, Huddersfield; Robert William Eddison (John Fowler and Co., Leeds, Limited), engineer, Leeds; Robert Hudson, engineer, Gildersome Foundry, near Leeds; Samuel Ingham (Illingworth, Ingham, and Co.), timber merchant, Leeds; Arthur Greenhow Lupton (Wm. Lupton and Co.), cloth manufacturer, Leeds; John Thomas Pearson, Melmerby Hall, Thirsk.

Report of the Directors and statement of accounts to be presented to the ordinary general meeting of the Company, on Wednesday, the 28th December, 1892, at 2.30 o'clock.

A freehold estate in Whitehall road, Leeds, immediately behind the Great Northern Railway Station Hotel, containing upwards of an acre, admirably adapted for the Company's purposes, and having the advantage of a river frontage, has been purchased. The property includes several workshops and other buildings which are not at present required by the Company, and from which a rental is being derived. The erection of works has been vigorously pushed forward, but it has been found impossible to complete them as soon as was expected, and it will probably be early in the coming year before they are in operation. Underground culverts, about 10,000 yards in length, for the reception of distributing cables, have been laid, and the drawing in of the cables is now in rapid progress. An arrangement was made with the Highways Committee of the Leeds County Council, for the necessary trenching to be undertaken by their staff, by whom the work has been admirably and expeditiously done. The applications for supply of current already received are sufficiently numerous to lead the Directors to anticipate a successful business for the Company. The whole of the present Directors having been appointed under article 77, their appointment will require confirmation by the shareholders. The retiring Directors, Mr. Grosvenor Talbot and Mr. Robert William Eddison, being eligible, offer themselves for re-election. Mr. John Gordon, jun., offers himself for election by the Company as auditor.

Dr. BALANCE-SHEET, JUNE 30, 1892	£	s.	d.
Capital authorised 100 founders' shares £5 each	500	0	0
19,900 ordinary shares £5 each, . . .	99,500	0	0
	£100,000	0	0
Capital issued and called up, 100 founders' shares (£5 each), £500; 6,718 ordinary shares (£2 10s per share called), £16,795; less calls in arrear, £1,983	14,812	0	0
	£15,312	0	0
Loan on mortgage of land and premises in Whitehall road, Leeds .	6,000	0	0
Directors' remuneration .	125	0	0
Sundry creditors	616	10	5
	£22,053	10	5

Cr.	£	s.	d.
Freehold land and buildings	10,189	15	4
Machinery . .	304	2	11
Mains . . .	4	4	1
Cost of provisional order .	936	19	10
Preliminary expenses	1,236	14	5
Sundry debtors	21	6	6
Cash on deposit with Board of Trade	5,000	0	0
Cash at bankers	4,270	4	10
Cash in hand	0	2	6
	£22,053	10	5

Gulcher Thermopiles. —The new Gulcher thermopiles made by Pintsch, of Andreasstrasse, Berlin, are being somewhat extensively used for chemical laboratory and commercial purposes, a very convenient means being thus afforded of obtaining small currents by the simple turning on of the gas. The following details are given: No. 1, 26 elements, 1.5 volts, internal resistance 0.25 ohm, gas $2\frac{1}{2}$ cubic feet per hour, price £4 5s.; No. 2, 50 elements, gas 4.6 cubic feet, 3.0 volts, 0.50 ohm, £8; No. 3, 66 elements, 4.4 volts, 0.65 ohm, gas 6 cubic feet, £9. 10s. The efficiency of these thermopiles is greatly superior to any previous types.

BUSINESS NOTES.

Falmouth is still enquiring of companies on the cost of electric light.

Llandaff.—The Court-room at Llandaff is still lighted by candles only.

Holborn.—The Holborn Board of Works intend spending [illegible] on lighting the Town Hall by electricity.

Hampstead.—The Hampstead Vestry have decided to undertake the supply of electricity in the parish.

Western and Brazilian Telegraph Company.—The receipts for the week ended December 16 were £3,387.

Norwich Telephones.—The Thanet Telephone Company intend to open a service in Norwich at the New Year.

Wimbledon.—The inhabitants of Wimbledon are again taking up the discussion of a scheme for electric lighting.

Walsall.—The Walsall Town Council have resolved to [illegible] ask the South Staffordshire Tramways to extend their line.

South Staffordshire Line.—The actual opening of the line has been postponed to next week, in order to have the [illegible] cars ready.

Kingswood.—The question of examining the [illegible] appliances throughout the district has been referred to [illegible] Committee.

St Pancras.—The St. Pancras Vestry has decided to [illegible] plans and estimates for an extension of plant for 25,000 [illegible] 16 c.p. lamps.

Magdeburg.—The contract for lighting the quays at Magdeburg has been given to the enterprising firm of Messrs. [illegible] Co., of Dresden.

Edinburgh.—The deputation from the Edinburgh Town Council appointed to obtain information on electric lighting has been in London inspecting various central stations this week.

Elmore's French Patent Copper Depositing Company.—Warrants have been posted for the 10 per cent. dividend on the preference share capital for the half-year ended November 1.

West India and Panama Telegraph Company.—The receipts for the half month ended December 15 are £2,511, as compared with £2,544. The August receipts, estimated at £3,921, realised £3,947.

Plymouth.—The Works Committee say they have no intention of introducing the trolley system as yet, but have [illegible] powers in case experience demonstrates the success of [illegible] traction.

Claybury.—The tender of Messrs. Appleton, [illegible] Williamson, of Queen Victoria street, at £[illegible] for [illegible] fittings at Claybury Asylum, has been accepted by the [illegible] County Council.

Accumulators.—We have received the price-list [illegible] S. Phillippart fils et Cie. of the Faure-Sellon-Volckmar [illegible] newest types are well illustrated. The office of the company [illegible] 26, Rue de Chateaudun, Paris.

Embankment.—The London County Council have deposited [illegible] General Powers Bill, in which, among other things, powers are sought for the lighting of the Victoria embankment and [illegible] and Westminster Bridges by electricity.

Partnership.—The following appears in the *Daily News*: "To scientific gentlemen. Wanted, a partner (sleeping or otherwise) in an exceptionally promising undertaking of a [illegible] nature. Apply for further particulars, 912 L., *Daily News* Agency Office, 67, Fleet street, E.C."

Mechanical Pumps.—The most interesting exhibit at the recent Mechanics' Fairs at Boston was that of the Boston Vacuum [illegible] and Electrical Company. Incandescent lamps are exhausted by a mechanical vacuum pump, having a capacity of 376 lamps at a time, at the rate of 5,000 a day.

Crompton and Co., Limited.—The Directors have declared interim dividends for the six months ending September 30 last, at the rate of 7 per cent. per annum on the preference shares of the Company, and at the rate of 5 per cent. per annum on the ordinary shares, payable on the 21st inst.

City and South London Railway Company.—The receipts for the week ending December 18 were £918, against £[illegible] for the corresponding period of last year, or an increase of £[illegible]. The total receipts for 1892 show an increase of £2,071 over those for the corresponding period of 1891.

Rawdon Foundry Company, Limited.—This company has been registered by Jordan and Sons, 120, Chancery lane, W.C., with a capital of £2,000 in £10 shares. Object: to carry on the business of mechanical and electrical engineers in all their respective branches. Registered without articles of association.

Heckmondwike.—The Heckmondwike Local Board have resolved by six votes to five, one member being neutral, to apply to the Board of Trade for consent to carry out a scheme for lighting the town by electricity, and to apply for the sanction of the Local Government Board for borrowing powers in the matter.

Scarborough.—About £10,000 capital has already been subscribed for the Scarborough Electric Lighting Company, and the directors have gone to allotment. The whole of the machinery and plant is on order, and Mr. Campbell Swinton, the managing director, hopes to begin building immediately after Christmas.

Chelsea.—Mr. Brass considers the electric lighting [illegible] Chelsea, driven by power obtained from the destructors, would be

£6,000. Estimates are to be submitted. Mr. Brass considers that the Vestry should also deal with the whole question of private lighting in the manner that the St. Pancras Vestry have done.

Leeds.—It will yet be a few weeks before the permanent plant is complete in Leeds. Meanwhile, by special arrangement, certain of the customers are being supplied till after Christmas by temporary plant. Pipes have been laid in all the principal streets and the cables are being drawn in, over eight miles of cable having been placed in position.

African Overland Telegraph.—It is understood that Mr. Rhodes will personally urge on the Egyptian Government his proposal to link Egypt with South Africa by telegraphic cable. He has left London for Paris, to proceed *viâ* Brindisi to Egypt, and subsequently will leave in a German East African Company's steamer for Mozambique.

York.—The Corporation have received some 15 tenders for a first installation of a central electric light installation for the city, and are now considering which it is to their interest to accept. The introduction of the electric light into the city in connection with the new Courts of Justice, police, and other offices has been a satisfactory introduction of the light.

Telephonic Alarm Stations.—The Cardiff Watch Committee on Monday decided to establish a series of telephonic alarm stations throughout the town. The precise number and situation of these telephonic stations was left over until the borough engineer should submit to the committee an ordnance map of the borough, indicating where the head constable proposed to put the stations.

Weston-super-Mare.—The Electric Lighting Committee of the Weston-super-Mare Commissioners consider that the electric lighting scheme should be left over until the question of a refuse destructor is settled. The instance of St. Phillips was mentioned, where a 40-h.p. engine worked from the destructor generated electric light. The surveyor will present a report on the subject.

Eastern Telegraph Company, Limited.—This Company announces the payment, on January 13 next, of interest of 3s. per share, less income tax, being at the rate of 6 per cent. per annum on the preference shares, for the quarter ending December 31; and the usual interim dividend of 2s. 6d. per share on the ordinary shares, tax free, in respect of profits for the quarter ended September 30.

Madras Tramways.—Mr. Digby, the chairman of the Madras Tramway Company, has visited Madras, and it is understood that the encouragement accorded makes him hopeful that the whole of the capital required will be subscribed. The statement of the prospects of the company, says the *Indian Engineer*, reaffirms the conviction that it will prove remunerative and constitute an excellent investment.

Blackpool Tramways.—A special meeting of the Blackpool Town Council was held last week, the Mayor presiding, when a statutory resolution approving of the application for a provisional order for the construction of further tramways was carried. A recommendation that all the members of the Council visit Helsby, near Warrington, in order to inspect the "Brain system" of closed conduits for electrical tramways was adopted.

General Electric Company.—With reference to a supposed rumour that the firm of Smeeton and Page were partners, or otherwise controlled by the General Electric Company, this latter company wish to make it distinctly understood that there is no relation whatever between them, except that of ordinary business customers. It has been the consistent policy of the company to supply goods only, and not to tender for erecting work.

National Telephone Company.—A circular has been issued by the committee of the Sheffield Telephone Subscribers' Association calling attention to the form of agreement which the National Telephone Company is submitting to its local subscribers. The circular says: "As the agreement at present stands, it is one which leaves out of consideration altogether the interests of the subscribers, being drafted entirely from the company's point of view."

Greenock Exhibition.—We regret to have stated, by an association of ideas that can be understood, that the lighting of the Greenock Exhibition was carried out by Messrs. Paterson and Cooper. The arrangement was carried out, under the able management of Mr. W. B. Esson, by the Gulcher Electric Light Company, the engineer in charge at the exhibition being Mr. James Hollingham. The lighting has been very successful, the football matches by electric light being greatly appreciated.

Edinburgh.—At the meeting of the Edinburgh Town Council last week a deputation was selected to visit various towns and obtain information on the subject of electric lighting. The following are the members of the deputation: The Lord Provost, Bailies Steel and Walcot, and Messrs. Kinloch Anderson, Sloan, Mitchell Thomson, and Williams. It seemed, owing to the fact that eight members were suggested, that there would be a vote on the matter, but the necessity for a division was obviated by Bailie Macpherson withdrawing his name.

Yarmouth.—A largely-attended meeting of the members of the Ratepayers' Association was held on Wednesday last week at Yarmouth. The chief debate was upon the adoption of the Corporation of the electric light proposals, involving an expenditure of £15,000 to £20,000. In an animated discussion the action of the majority of the Town Council was condemned. A deputation was appointed to wait upon the mayor, asking him to convene a public meeting to discuss the subject. The mayor has intimated that he would grant the use of the Town Hall, provided a requisition, signed by 25 well-known ratepayers, is handed to him.

South African Exhibition.—The Executive Committee of the South African and International Exhibition have now made known the result of the jurors' investigations. The following gold medals have been awarded to Messrs. Mather and Platt, Limited, of the Salford Iron Works, Manchester: (1) For dynamos for electric lighting and electrical transmission of power; (2) for electric lighting plant; (3) for incandescent lighting plant; (4) for motors. We are also informed that Messrs. John Davis and Son, of Derby and London, have been awarded the following medals—viz.: Two gold, three silver, and one bronze for the following exhibits: Electric light fittings, incandescent electric lighting, safety lamps, surveying, drawing, and engineering instruments.

Barnet.—The Barnet Local Board seem decided at last to go properly to work for the establishment of a central electric lighting station in their district. They have applied to Prof. Robinson, who, as Mr. Schmidt said, was very well known in the electrical world, and one of the best men the Board could get, having carried out the St. Pancras lighting, the most successful central installation yet erected. Knowing the district, his fee would be 25 guineas for a report on the cost of the scheme. The chairman remarked it would be a matter for the future to decide whether the Board should carry on the installation or delegate their powers to a contractor. The chairman and Mr. James were appointed to meet Prof. Robinson and go round the district with him.

Westinghouse Lamps.—The Westinghouse Company has announced the price of its new separable lamps: 35 cents (1s. 5½d.) for 25 and 20 c.p. lamps, and 30 cents (1s. 3d.) for 16, 10, and 8 c.p. lamps, with discounts of 2½ to 10 per cent., according to quantity. The allowance for the return of the globes to the factory will be 10 cents each, so that the net price of the 16, 10, and 8 c.p. lamps, which form the greater proportion of those used, will be only 17 cents (8½d.). The net price of the 20 and 25 c.p. comes out at 21½ cents (10¾d.) each. The efficiency of the 50-volt lamps is placed high, 2½ watts per candle being mentioned. It is claimed that the saving to a central station by the return of the globes and the low prices may be as much as nearly 1 per cent. dividend on the shares.

Telephone Charges.—At the meeting of the Newport Harbour Commission last week, Messrs. E. P. Jones and Son sent a long letter with reference to the proposals of the Post Office to charge conversation for the use of all trunk telephone lines after January 1. They thought the system was a wrong one, and asked for the expression of the Board's opinion. Mr. Heard proposed that the Board support the action of the Associated Chamber of Commerce in endeavouring to induce the Post Office to substitute rentals for conversation fees. Mr. Ward spoke against the motion, and thought that the fee system would be the better, although it might give persons who used the trunk lines a little more trouble. The chairman thought it would be a great deal more trouble. The motion was agreed to.

Andaman Islands Telegraph.—Mr. John Eliot, meteorological reporter to the Government of India, says the *Indian Engineer*, while approving of the laying of a telegraph cable to Port Blair, doubts whether Government would deem it advisable to incur the necessary outlay (some 15 lakhs of rupees) until the port authorities of Calcutta take the initiative by laying a cable from the Eastern Channel lightship to Saugor Island. This would enable the light-vessels and pilot-vessels to be effectively warned of the character of all approaching stormy weather, and give at least six hours' earlier definite information to the port authorities in Calcutta of the intensity of storms approaching the mouth of the Hooghly and the port of Calcutta. In our opinion, adds our contemporary, both cables are desirable if not absolutely necessary, and we trust that both the Government of India and the port authorities of Calcutta will take speedy action in the matter.

Haslingden.—At the Haslingden Town Council meeting last week the chairman (Councillor Barlow), on behalf of the subcommittee, reported that in accordance with the instructions of the committee, the sub-committee appointed to gather information relative to the electric lighting had visited Nelson, and as a result of enquiries made there they waited upon Mr. Barton, electrical engineer, of Blackburn, relative to the putting down a plant and the supplying of electric light to the public street lamps and the tradesmen of the borough, etc. The sub-committee made arrangements with Mr. Barton for him to visit Haslingden, and furnish them with a report upon the electric lighting of Haslingden. Mr. Barton's report was read to the committee, and after some discussion thereon it was resolved that the report of the committee be received and adopted, and that the report of Mr. Barton be printed and forwarded to each member of the Council for their consideration.

Bolton Tramways.—A special meeting of the Bolton Town Council was held on Monday, when the principal business was a discussion in regard to the proposed application for parliamentary powers to permit of the Corporation operating the tramways themselves, and borrowing the requisite funds for so doing. A large majority of the Council were favourable to the proposal on the grounds that the Corporation ought to safeguard its position by this power; that it would popularise the tramcar service, economise it, and improve it, and secure better working conditions for the tram employés. It was also suggested that, seeing the Corporation are contemplating adopting electricity, that they ought to be in a position, if necessary, to adopt it to the tramcar service. It was contended, on the other hand, that there was no need to obtain the powers suggested, seeing that the trams were already efficiently managed, and that it was possible the Corporation might not avail themselves of the privilege if they secured it. The proposal to obtain powers was, however, carried by 30 votes to 5.

Cardiff.—A meeting of the Electric Light Committee was held on Tuesday, the Mayor presiding. The town clerk read a draft agreement between the Corporation and Mr. Massey, as consulting engineer, at the remuneration of 5 per cent. on the outlay. The agreement was ordered to be signed. Mr. Massey stated he had been instructed, with the borough engineer, to prepare plans and specifications for the central station, so that the Local Government Board inspector might come down. A building twice the size needed was provided, and allowance for extra mains, the total cost being about £32,500. The station would be equal to all requirements for six years, and the chimney for 12 years. After a brief discussion it was agreed that the estimates be adopted, and that the necessary steps be taken for obtaining the sanction of the Local Government Board for borrowing the money. The borough engineer was instructed as soon as this has been done to advertise for tenders.

Windsor.—The Windsor and Eton Electric Light Company which has just laid down its mains at Windsor was summoned on Monday before the borough magistrate for breaking up the streets without the permission of the Town Council, which had been refused in consequence of the company having failed to satisfy the Board of Trade that it was able to fulfil the duties and obligations conferred upon it by the provisional order. Mr. C. H. Long, the town clerk, prosecuted. The engineer in carrying out the works had displaced 4,711 square feet of pavement, and the company, which admitted its offence, had by its breach of the local regulations rendered itself liable to maximum penalties amounting to upwards of £1,182. The Bench, however, took a lenient view of the matter, and inflicted a fine of £2 and another of £9. 18s., the latter sum representing a halfpenny a foot for the area of pavement disturbed. The company also had to pay the cost of the proceedings, which, however, were inconsiderable.

Ogmore.—On Monday, Tynewydd and Nantymoel, in the Ogmore Valley, near Bridgend, were lighted by electricity for the first time. The ceremony of switching on the current took place simultaneously at half past six, being performed at Tynewydd by Mrs. Williams, wife of Alderman Williams, chairman of the company, and at Nantymoel by Mrs. D. Sims Rees, wife of the vice chairman, in the presence at each station of a number of the directors and shareholders. The lighting is on the incandescent low pressure continuous current system, and the public lamps are of 16 c.p. The current is generated at each station by two compound wound and self regulating dynamos worked by a duplicate expansion engine of a nominal 35 h.p. There are two reserve dynamos, and each machine is capable of supplying 200 lights each. The light has been adopted in nearly all the principal shops and buildings, and proved a great success. The whole of the work has been carried out by Mr. G. Wilson, electrical engineer, of Aberdare, and the undertaking belongs to a limited company.

Fleetwood.—At a meeting of the Lighting Committee of the Fleetwood Commissioners on November 29th, it was recommended unanimously that the clerk be authorised to obtain from Messrs. W. H. Preece, F.R.S., and T. L. Miller, their terms for proposed services as electrical advisers upon tenders already received. The report upon proposed electric lighting at Yarmouth and other towns was read. On December 7th the committee again met. A communication was read from Mr. T. L. Miller, consulting engineer to the Bootle Corporation, stating his fee for going through the tenders received and advising the committee would be 35 guineas. The other gentleman who had been asked had given his fee as 50 guineas. Mr. Nicholson asked if they were far enough ahead to spend 35 guineas? The chairman said they were at a standstill now. Mr. Shuttleworth said this was information they would be compelled to get sooner or later. The chairman said that Mr. Miller was an independent gentleman, and his advice would be valuable. He had been recommended by Mr. George Curwen, of Liverpool, Mr. Allsop, of Preston, and others. Mr. Shuttleworth made the remark that "the charges of London experts were extravagant," after which it was decided that Mr. Miller be appointed electrical adviser.

Poole and White, Limited.—Under the winding up of Poole and White, Limited, a statement of affairs was issued on Monday by the Official Receiver. The gross liabilities as to creditors are returned at £23,293, against which £10,104 was expected to rank for dividend. The estimated net assets, therefore, stand at £11,885. As regards contributories the total deficiency is £16,082. The Company was registered in February, 1890, for the purpose of acquiring and carrying on the business of Poole and White, electrical engineers, of Broad street. The nominal capital was £20,000, divided into 3,400 ordinary and 600 deferred shares of £5 each. Debentures to the extent of £11,000 were issued since February, 1892, the consideration being, it is stated, cash in all cases. The failure of the Company is attributed generally to insufficiency of capital. The creditors appearing as fully secured are stated to hold a mortgage on the uncalled capital of the Company. "It may be noted," says the Official Receiver, "that the whole of the assets have been put beyond the reach of the ordinary creditors within the last 12 months, except in the case of one of the fully secured creditors, whose mortgage for £1,000 is stated to have been given in 1890."

The Cable Service to Australia.—The representatives of New South Wales, Victoria, South Australia, New Zealand, Tasmania, and Western Australia (says the *Times* of Monday) have signed, on behalf of their respective Governments, an agreement with the Eastern Extension Telegraph Company increasing the charge upon Australasian telegrams by 9d. per word, *i.e.*, making the rate to Australia 4s. 9d., instead of 4s. per word, which was the amount paid last year under the guarantee arrangement entered into between some of the colonial Governments and the company, under which the rate was reduced from 9s. 4d. to 4s. per word, the loss being equally divided between the two contracting parties. Up to the present the Indian Government had made no sign of abandoning their expressed intention of increasing the transit rate upon Australasian messages from 35 to 50 centimes per word. The Secretary of State has conveyed to the Indian Government the strong representations which the colonial Governments had made against the decision, which they regard as most unreasonable, [illegible], and unfair to the colonies; but, since no response has been made, it is thought that the Indian officials will be hard to [illegible]. As it was important that the changes of tariff should be brought into operation on the 1st prox., it became necessary to sign the agreement without waiting for a definite reply from India. The colonial Governments will continue to press their objections to the increased Indian transit rate, as they have placed on record that if it is insisted upon it will involve the colonies in very serious [illegible], and may lead to a return to the former high tariffs.

London County Council.—The Highway Committee report that the chief engineer has asked that Mr. H. W. Ridley, who was appointed on December 13 as an electrical assistant, may be formally appointed as an inspector under the electric lighting Acts and orders. The engineer states that Mr. Ridley is competent to discharge the duties of an inspector, and expresses the opinion that the work of the Council would be [illegible] should Mr. Ridley be appointed to the position. Compliance with this request of the engineer will not involve any alteration of Mr. Ridley's salary; and, as the committee think that advantage may result from such compliance, they recommend Mr. Ridley be appointed to discharge the duties of an inspector under the Electric Lighting Acts. The committee have considered a notice dated December 12, 1892, from the House to House Electric Light Supply Company, of intention to lay mains in Cresswell gardens. These mains will be laid in 3in. cast iron pipes, and the proposed works appear to be unobjectionable. They recommend that the sanction of the Council be given to the works referred to in the notice upon condition that the company do give two days' notice to the Council's chief engineer before commencing the works in any of the streets referred to in the notice; that no pipe of a larger diameter than 6in. shall be used; that the street boxes shall be of the pattern approved by the Council; and that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, the two insulated from each other as far as practicable, and that the outer cover shall be efficiently connected to earth.

Yarmouth.—At the meeting of the Great Yarmouth Town Council last week the committee recommended that the electric lighting of the town be proceeded with at once by the Corporation, that application be made to the Local Government Board for sanction to borrow the sum of £15,000 for the purposes of electric lighting, which would allow for 50 to 100 arc lights for street lighting, in addition to the 4,500 private lights, and that Mr. Preece be instructed to get out the necessary specifications for both street and other lighting, subject to a satisfactory arrangement as to fees. A letter was received from the Yarmouth Ratepayers' Association, urging the Council not to adopt the scheme for electric lighting. Mr. Martins moved the adoption of the report. Mr. Wiltshire thought there would not be a demand for even 4,500 lamps. They ought to start with [illegible]. An extension of time ought to be asked for. The price to be paid for specifications was far too much. Mr. Preece had been paid £50 already, and 5 per cent. on £15,000 would amount to £750. He thought they did not need Mr. Preece's services at that [illegible]. He moved the whole matter be referred back. Mr. Martins said the terms would come before the Council for approval. He gave particulars of success at Bath and Bradford, and thought Yarmouth was well fitted to have the light. The Mayor supported the amendment, but substituting, instead of reference back, that the resolution to proceed at once be omitted. This was [illegible], and Mr. Paston moved a further amendment that the instructions to Mr. Preece and his reply as to terms be submitted to the committee, with directions to draw up a report, and this amendment was carried.

Windermere.—At the monthly meeting of the Windermere Local Board, the report was considered of the committee appointed to consider upon what terms the Board should grant permission to lay down an electric cable through the Board's district. Mr. Irving said that the committee found that various difficulties presented themselves, the most vexatious of which was the uncertainty as to the agreement arrived at between Mr. Fowkes and the Bowness Local Board, by which the latter wished to ignore the Windermere Board altogether. Mr. Fowkes had promised to supply the clerk with a copy, but was cautioned to attempt to do nothing of the kind. An application to the clerk of the Bowness Board effected no better results, so that the committee were left entirely to their own resources in endeavouring to find out what had been done. They had visited Keswick, where they found the electric light was being supplied to private customers at the rate of 4½d. per unit, but not for public lamps, and the electricity was conveyed by overhead wires. During the greater part of the year the company were enabled to generate the electricity by water power at an extremely cheap rate. Since commencing, they had been able to declare a dividend of 3 per cent. on the outlay, with a reserve for exigencies. The cost of gas at Keswick was 3s. 4d. per 1,000ft., and the gas company were also paying a satisfactory dividend. Electricity at 6d. per unit was taken as representing gas at 3s. per 1,000. Mr. Irving then read the report, and after prolonged discussion proposed that it be received, and that the

extra cost of the electric light above that of gas being about £500 a year. The question of the Council acquiring the electric light undertaking from the company has been, as our readers are well acquainted, under consideration for more than a year, and various negotiations have been carried out, till at length it was decided to offer the company a certain sum of money for their works and goodwill. The Council have been practically unanimous in their action, one gentleman only being consistent in his opposition. Mr. Kapp was employed to report upon the matter, and his report was presented on the 3rd of May, and negotiations for the purchase of the company were carried on according to Mr. Kapp's valuation. The town has some 10 miles of streets, and the cost of laying down mains for the whole would be somewhat large. If only a few streets had that system, it would be scarcely fair to the rest. The streets were very well lighted now, and the Corporation wanted to extend the electric light as much as they could. A number of witnesses were then examined, the first of whom was Mr. Meyler, the town clerk, who produced the minutes of the Council, and gave evidence as to the general consensus of opinion being favourable, and that certain complaints were hardly warranted by the facts. The ex-Mayor also gave evidence of a similar character, in addition to which, however, he made a personal statement that he was a large user of the electric light and desired to retain it. The borough surveyor, Mr. J. H. Smith, said he had many deputations to see the electric light. He considered the present light much superior to the old system. They used to be "chaffed" a good deal about the old gas lamps. An alderman said a thief could escape if he stood under a gas lamp. There were 60 gas lamps removed when electric light was installed, and there were now 253 gas lamps and 36 electric. He made a report of the vibration complained of at the works, and considered there was no ground for the complaint. He received a letter that morning from a gentleman residing near the works, in which he said he found no vibration at all. There was a greater length of cable laid than streets lighted. By Mr. Clarke: There was something in the objection about the steam at the works. He was waiting to take over the works to remedy it. The cost last year of lighting the streets was £1,334. He had not calculated on the cost of lighting the whole streets with electricity. When they had gas the hours of lighting varied; some lamps were on all night. The electric light went off at three in the morning, as it was considered a waste to burn them longer. The cost of lighting by electricity was greater. In reply to a question of Major Cardew, he stated that the present cost of arc lamps was £22 16s. by contract, and the price was to be £25 per year. The chairman of the Lighting Committee (Mr. Henry J. Van Trump) gave evidence in perfect accord with that of the ex-Mayor. He stated that the electric light was one of the best advertisements Taunton ever had. Mr. Blakey, assistant electrician to the company, said the length of cables was 7½ miles. There had been an increase in the number of lamps installed of 491 in November last year against 917 this year. The latter had increased during the past few months. There were two private ones increased. Mr. Massingham had an installation lately of 120 incandescent lamps. The whole apparatus had worked more efficiently under the increased load, and the cost of coal had been less this year against £87 for November last year. The development of the work was hindered because there had been an insecurity of feeling as to the existence of the light. Dr. Fleming, who had been called in to make a report on behalf of the Laing, Wharton, and Down Syndicate, also gave evidence. He did not agree with Mr. Kapp in all his statements, and as regarded the cost per lamp for 50 lamps, he put it for each arc lamp at £28. The gas company naturally opposed the application, so far as we can glean, principally on the ground that it would be a disastrous failure in the future as in the past, and that loss would have to be borne by the ratepayers, instead of falling on the shoulders of the company. Mr. Kapp also gave evidence, and stated his reasons for not agreeing with the existing system. He gave an estimate of what the outlay would be for carrying out Dr. Fleming's plan, showing that there would be a loss of about £1,100. Other witnesses were called, and Mr. Pritchard shortly replied. A great many of the expenses, he said, that were mentioned in Mr. Kapp's figures would not be necessary, at least not until the incandescent lighting was extended. He (Mr. Pritchard) admitted that the Council would want a large capital beyond the £9,000 for the purchase. The cost of the current for arc lighting was considerably less than the figure mentioned by Mr. Kapp, and in that way the working expenses would be reduced. There could be no doubt that the price, £9,391, was a very low one, taking into consideration that the Council were not only purchasing the works, but also the goodwill and all the customers ready to hand. He had to ask the commissioners to report favourably to the Board of Trade, and then Taunton would not only have the best supply of water, the best drainage, but also the best system of lighting. Sir T. Blomefield: I must say that they are the best lighted streets in Taunton I have ever seen. This concluded the enquiry.

PROVISIONAL PATENTS, 1892.

DECEMBER 12.

22780. **Improvements in the method of and apparatus for electrolysing aqueous solutions of salts.** John Ashton Heap, 15, Corinne road, Tufnell park, London.

22804. **Improvements in electric hair and skin brushes.** George Ive Spalding and Richard Leonard Hawkins, 34, Southampton buildings, Chancery lane, London.

22836. **Improvements in or relating to the constr[uction of] electric accumulators.** William Phillips Th[ompson,] Lord street, Liverpool. (The S[chlesische?] E[lektricitäts] Gesellschaft, Raab and Bastiane, Commandit schaft, Germany.)

22837. **A combined knocker and electric bell contact.** Septimus Hooker, 27, Martin's lane, Can[non street,] London.

22838. **Improvements in long-distance telephones.** Aubrey Day, 321, High Holborn, London. [(…] Marshall Haynes, United States.) (Complete [specifica]tion.)

22854. **A new or improved electric arc lamp.** He[…] Norfolk House, Norfolk street, Strand, Lond[on. (…] Archat, France.)

DECEMBER 13.

22858. **An improved electric arc lamp.** George Dav[…] John street, Adelphi, London.

22889. **Improvements in electrical fittings, also app[licable to] other purposes.** Arthur Firth and George [...]well, 15, Abbey street, Greenheys, Manchester.

22914. **Improvements in printing telegraphs.** W[illiam] Wise, 46, Lincoln's inn fields, London. (Char[les] Buckingham, United States.) (Complete spe[cification.)]

22915. **Improvements in printing telegraphs.** W[illiam] Wise, 46, Lincoln's inn fields, London. (Char[les] Buckingham, United States.) (Complete spe[cification.)]

22923. **Improvements in or relating to electr[…]** Sebastian Ziani de Ferranti, 6, Lord street, Li[verpool.]

22925. **Improvements in long-distance telephonic tra[nsmitters] of and receivers of sound.** Robert Henels e C[…] 11, Lambourne road, Clapham, London.

22931. **Improvements in printing telegraphs.** Will[iam] Wise, 46, Lincoln's inn fields, London. (Char[les] Buckingham, United States.) (Complete spe[cification.)]

22947. **A new or improved method of utilising waste [...] water supply systems for generating [...]** William Lowrie, 433, Strand, London.

22950. **An improved galvanic dry battery or cell, an[d com]position for use in such cells.** Reginald H[…] Buckingham street, Strand, London. (Ramon [...] Spain.) (Complete specification.)

22951. **Improvements in switchboards for use in the [distribu]tion of electrical energy.** Rookes Evelyn Bell C[rompton,] 55, Chancery lane, London.

22958. **Improvements in lightning arresters.** Willia[m] Garton and John Garton Davies, 53, Cha[ncery lane,] London. (Complete specification.)

DECEMBER 14.

22987. **Improvements in secondary battery plates or [...] and in the process of preparing same.** Ph[ilip] Justice, 55, Chancery lane, London. (W[…] Griscom, United States.) (Complete speci[fication.)]

23007. **Improvements in galvanic batteries.** W[…] and Frank Richard Wilkins, 128, Colm[ore row, Birming]ham.

23022. **An improved loud-speaking telephone.** Alfr[ed …] 1, Gresham buildings, Guildhall, London.

SPECIFICATIONS PUBLISHED.

1891.

12484. **Telephonic switches.** Bennett. Second ed[ition].

22304. **Electric signalling for telegraphic, etc.** [...] Thompson.

1892.

1141. **Dry electrical elements.** Vogt.

1216. **Electric cut-outs.** Korten.

1734. **Electric compasses, etc.** Von Pruchl.

4709. **Electric wiring.** Yorke.

11104. **Telephonic apparatus.** Hammarlund.

15813. **Junctions for electric mains.** Thompson.

COMPANIES' STOCK AND SHARE LIS[T.]

Name	Paid.
Brush Co.	—
— Pref.	—
City of London	
Electric Construction	10
Gatti's	—
House to House	5
India Rubber, Gutta Percha & Telegraph Co	10
Liverpool Electric Supply	5 / 3
London Electric Supply	.
Metropolitan Electric Supply	—
National Telephone	5
St. James	—
Swan United	3¾
Westminster Electric	—

the spurs touched the horse's flanks the poor brute was noticed to act as if in great pain. As was but natural, the judges observed these actions, and enquiries made into the occurrence resulted in the jockey being disqualified for barbarous conduct. He was then ruled off the course.

An Electric Mail Car.—There has just been introduced in the city of St. Louis, Missouri, the first postal tramcar in the United States, and probably in the world. The car, which is on an electric route, traverses five miles in 35 minutes, during which it collects mail matters from carriers who are in waiting at 10 or 11 different stations, where also the letters are delivered which have been sorted on the car. By avoiding the old plan of sending all postal matter to a central office for sorting, a great deal of time is saved. In fact, one letter is reported to have been delivered 26 minutes after it was posted, and tradesmen and others are now expected to make use of the post to a greatly-increased extent for the rapid delivery of parcels and messages. The cost of the present experiment, carried out by the desire of the local postmaster, has been defrayed by the tramway company; but it is hoped that the United States Government will now take the matter up.

Distance Switches.—M. P. Simon, in *L'Electricien* for December 24, illustrates an electromagnetic switch for turning off lights at a distance. Two electromagnets, mounted at right angles, control two armatures, which are pressed back by springs in the usual way. One of these carries a triangular piece of metal, which, when one of the push-buttons is pressed, is pulled down, making contact between the two wires for the lamps; at the same time it becomes hitched in a catch on the other magnet armature, and so held in place. To turn out the light, the second button is pressed and the catch is released. Nothing can be simpler than the idea, and, says M. Simon, there are more advantages to be claimed for this kind of switch than at first appear. They allow all the switches to be fixed in one place, and, if need be, under one lock and key; the extra lengths of wire of the main cables or wires are not needed, as the switches can be fixed at the nearest point, and only a couple of small wires brought back; they allow a great control over the expenditure of current, thus reducing the running cost. In some circumstances such electric switches might certainly have a useful place.

High-Tension Discharges.—The long sparks from high-tension currents, 31in. between the terminals, which were produced by Prof. Elihu Thomson last April, have been greatly surpassed by the same intrepid investigator. Streams of sparks between terminals 64in. apart have been obtained, and even this great length was limited by the mechanical construction of the apparatus, and not by the limit of sparking distance. The torrent of bluish-white sparks differs little from the appearance of the shorter discharge, except in the development of lateral discharges, which leave the electrodes in all directions, forking through the air a distance of several feet, not always towards the opposite terminal. The curious part about this interesting experiment is that the transformer used had only 480 turns on the secondary in a coil 17in. diameter and 28in. long, immersed in oil, while the primary, which receives the condenser discharges, has 15 turns only. The sight of the successful taming of lightning flashes 5ft. long is in itself sufficiently extraordinary, while the possibility of obtaining such enormous potentials, though at present little more than a *tour de force*, may conceivably lead to very important results in practical work, in the same way that the explosive force of high-pressure steam has been tamed and applied.

High-Tension Transmission.—An installation of a type that will tend to multiply has recently been started in San Antonio Canyon, California. The installation is erected for the purpose of supplying Pomona and San Bernardino from San Antonio, where there is a fall of water 1,300 cubic feet per minute, with a head of [illegible] The water is brought to the power-house through 1,900ft. of 30in. and 600 24in. double-riveted sheet-iron pipe, which absorb by friction a head of 12ft. The power station is provided with four double-nozzle Pelton wheels 34in. diameter, coupled direct to alternating Westinghouse dynamos of 200 h.p. each, running at 600 revolutions. Two exciters are run by two Pelton wheels of 20 h.p. The current is transformed up to 10,000 volts, and carried on two No. 7 bare copper wires seven miles down the canyon to a point where they diverge, one running to Pomona, [illegible] miles, and the other to San Bernardino, 28 miles distant. The current is transformed by step-down transformers outside these towns to 1,000 volts, and distributed for both light and power purposes, the motors used being of the Westinghouse synchronous type. The sub-stations are provided with regulators, so that the attendants can regulate the voltage independent of the generating plant.

Lighting of Nelson.—On Friday last, in the presence of several members of the Nelson Town Council and other guests, the ceremony was performed of inaugurating the electric light installation which the Corporation of Nelson have just established in the borough. Alderman Hartley, chairman of the Gas Committee, formally turned on the switch, and during the proceedings it was stated that Nelson had achieved the distinction of being the first Lancashire town where the Corporation had completed a public electric light installation. The distributing mains are laid in the principal streets of the town and tradesmen have become guarantors for the use of about [illegible] lights, the cost of the installation to be wholly met by the consumers of the light. The Corporation have also placed a 2,000-c.p. lamp in the centre of the town, and it is intended to place a similar lamp in front of the market. The cost of the installation, which has been made by Mr. T. Barton, of Blackburn, has been about £4,000. The generating station is at the Corporation gas works, and the steam pressure of 80lb. required for driving the engines is supplied by waste heat from the retort house, thus economising the cost of working the installation. The engine and dynamo are capable of supplying electricity for 600 lamps for 16 c.p. each. The distributing mains are laid in iron troughs placed underground, the cables being of 61 strands, insulated. During the evening the streets where the electric illumination is supplied were traversed by a large number of interested spectators.

Mirror High-Tension Electrometer.—The electrometer of Herr Heydweiler, described in the *Zeitschrift für Instrumentenkunde*, is based upon the mutual repulsion of a sphere and a ring charged to the potential to be measured. In the hypothesis of a uniform distribution of electricity this effect is nil when the ball is concentric to the ring, and also at a great distance. If the sphere is passed from one position to the other along the axis of the ring, the effect increases to a maximum, to again diminish. In the position of maximum effect, the force is only dependent to a small extent on the distance between the sphere and ring. The instrument based on this effect is in the form of a torsion balance, the repulsion effect being double. Two rings are mounted side by side, into these protrude two arms carrying small spheres, the whole hung on a bifilar suspension, the arms being connected to a large centre ball. The size of the centre ball is 3.5 cm. diameter suspended by wires 01 mm. diameter and 9 cm. to 10 cm.

reduced speed of alternators; (4) their adaption to standard engine speeds; (5) all alternators self exciting and compounded; (6) alternators run in parallel; (7) carbon brushes on all alternators set at 80deg. to 90deg.; (8) alternators driven direct, even down to 100 h.p.; (9) one type of dynamo in central stations—said dynamo to render all kinds of service required; (10) higher primary voltages all round; (11) engines and dynamos regularly inspected by a company formed for that purpose. Mr. Watts's motto, in characteristic American vein, is: "Man wants but little here below, nor wants that little long—but during the short time he wants it, he wants it bad." There is much to be said both for the idea of low alternations and for standard dynamos whose current may be made—converted or redressed—to do every service.

Dynamo Driving by Compound Engines. — A paper on the efficiency of engines for dynamo driving was read before the October meeting of the Engineering Association of New South Wales by Mr. P. Diamond, illustrated with diagrams from actual engines. He quoted the article from *Engineering*, January 29, 1892, giving the difference in power required for electric lighting, citing Newcastle-on-Tyne, where the lightest load was 15,000 watts, and the heaviest 170,000 watts, or only 0·088. At the St. James's and Pall Mall stations, December, 1890, at 4 p.m. to 4.30 a.m., the load was 20,000 watts, and at 6 p.m. it was 400,000 watts. Putting the latter into horse-power, they would be respectively about 26 i.h.p. and 536 i.h.p. If only one engine is used this would mean serious waste, depending on the relative time the smaller power was required. The Westinghouse Company publish a table in their catalogue giving the consumption of steam per indicated horse-power per hour, with varying loads, which for non-condensing engines ranges from 170 i.h.p. with 21·9lb. steam, down to 50 i.h.p. with 28·8lb. of steam. Mr. Diamond then discussed the diagrams which, with one exception, were from engines at work in Australia. No. 1 was from a vertical non-condensing Corliss engine, at Saltair, and came into the writer's possession about 1869. The cylinder is 16in. diameter, 3ft. stroke, making 80 revolutions per minute, the power developed being 164 i.h.p. Other lines dotted showed a greater and smaller power—viz., 186 i.h.p. and 116 i.h.p. The consumption of steam calculated for these powers were 28lb. for 186 i.h.p., and 25lb. for the 164 and 116 i.h.p. The lowest power is 0·623 of the highest, while the lowest consumption of steam to the highest is 0·89. No. 2 diagram was from a horizontal non-condensing engine which had been at use at the Randwick tram-driving station. Cylinders 13in. diameter, 1ft. stroke, 300 revolutions, developing 91·69 i.h.p. The power given out by dynamo was 530 volts and 105 amperes, making 75·93 e.h.p., giving an efficiency of 0·828, assuming 10 per cent. friction of engine. This seems a very good performance. The consumption of steam as calculated is 38·8lb. steam. This engine would not have a great difference in the consumption of steam for varied powers, as the cut-off was effected on the compression side of the diagram. No. 3 diagram was from a horizontal compound non-condensing engine at Parliament House, used for driving the electric light. The cylinders are 9in. and 14in. diameter, ratio of 1 to 2·42, stroke 16in., revolutions 118. The power developed is, for small cylinder, 21·6 i.h.p., and for large one, 24·2; total power is 45·88 i.h.p. the dynamo gives 111 volts and 233 amperes, equal to 34·66 e.h.p., and the efficiency is 0·755. In this diagram the power was very fairly divided between the two cylinders, and, if 10 per cent. be allowed for friction, this would give about 23 i.h.p. to take off each, and they would then give good results. The amount of steam as calculated is 29·5, but tests made gave a much lower consumption. No. 4 diagram was from a pair of horizontal compound non-condensing engines at the Centennial Hall, used for electric light driving. The diagrams were taken on September 7, 1891. The cylinders are 13in. and 23in. diameter, stroke 2ft., revolutions 109; the power of small cylinder is 102·72 i.h.p., and of large one 49·04 i.h.p., total, 151·76 i.h.p. The output of dynamo is stated as 103,250 watts, equal to 138·4 e.h.p, and the efficiency is 0·91. If 10 per cent. is allowed for friction, then the power which the engine could give out would be reduced to 136·6 i.h.p., or about 2 i.h.p. less than that given off [illegible] dynamo. These engines use, as calculated, 92·5lb. steam. The distribution of power, when compared to No. 3, is [illegible] very good, as the small cylinder is doing two-thirds of [illegible] work. The diagrams showed considerable back pressure [illegible] large cylinders, which gets as high as 2lb. before compression commences. No. 5 diagram was off the same engine as the No. 4, but was taken on the 23rd April, 1892, under the normal condition of the present lighting requirements. In this case the small cylinder shows 66·9 i.h.p., the large one 11·6 i.h.p.; total, 78·5 i.h.p. The dynamo was giving off [illegible] volts and 236 amperes, equal to 32·44 e.h.p. The efficiency is 0·41. If 10 per cent. of No. 4 power be allowed, this would give about 7 i.h.p. for each cylinder, and as the large one indicates only 11·6 i.h.p., this leaves about 4·6 i.h.p. which this cylinder could give out, and is further aggravated by the fact that at 0·7 of the stroke the pressure commences to go down below the pressure required for friction, and ultimately lands below the atmospheric line. The back pressure is the same as in No. 4. The calculated consumption of steam is 43lb., so that at about half the load the consumption of steam has increased by [illegible] per cent. These figures bring out the particular objection raised against the use of compound engines with greatly varying loads, and the writer regarded it as fortunate that these particular engines were only doing about half the work they were intended for, thus illustrating where the trouble lies, so that the remedy might be pointed out, and the character of the compound engine saved. No. 6 diagram was from a pair of horizontal compound non-condensing engines at Circular Quay lighting station; the cylinders are 8in. and 14in.; stroke, [illegible]; revolutions, 87; power shown is for small cylinder, 19·7 i.h.p., and for large one, 11·7 i.h.p. The power given off for 28 arc lamps is 18·7 e.h.p., the efficiency is [illegible] and the steam consumption 31·4lb. No. 7 diagram was from a pair of horizontal compound non-condensing engines at the Redfern lighting station. The cylinders are 13in. and 23in. in diameter, stroke, 2ft.; revolutions, [illegible], the power shown in small cylinder, 56·5 i.h.p., and in large one 26·1 i.h.p.; total, 82·6 i.h.p. The dynamo gives off 1,0[illegible] volts and 41 amperes, equal to 55·5 e.h.p., the efficiency is 0·68, the steam consumption calculated 36lb. In this case again the distribution of power was unequal, but the diagram is entirely free from the defects in the large cylinder of No. 5; the only lights in use are the street lamps, so that there is practically no variation in the load, and diagrams giving a heavier output could not be had. No doubt when the house-lighting is secured, and used, different results could be had. The Centennial Hall engines were driving light and heavy loads, all the others were driving steady loads. The calculation for consumption of steam is by an approximate method suggested by Rankine in his "Steam Engine" (p. 409), and mentioned in Cotterill "On the Steam Engine" (p. 58), and although not strictly accurate, gives a means of comparing the efficiency in diagrams which show any variation in feature

FIELD MAGNETS.

BY GISBERT KAPP, M.I.C.E.

(Concluded from page 632.)

The magnetic force required to produce an induction of $\mathfrak{B}_a$ lines through the armature, Fig. 66, is $H_a = \frac{\mathfrak{B}_a}{\mu}$, where

$$H_a = \frac{\cdot 4 \pi X_a}{L_a}.$$

We have, therefore, $\mathfrak{B}_a = \mu \frac{\cdot 4 \pi X_a}{L_a}$;

and in order to determine X_a, the ampere-turns required for the armature alone, we must know the value of the permeability at the particular induction chosen. This can be found experimentally (as was first done by Dr. Hopkinson in connection with the design of dynamo field magnets) by testing the particular sample of iron used for armature plates and determining the permeability curve, or better still, the magnetisation curve, representing $\mathfrak{B}$ as a function of H. We know what total flux we require to give the desired E.M.F., and by dividing this by the area of the armature core we find $\mathfrak{B}_a$. Then, referring to the magnetisation curve we find the corresponding H_a. The ampere-turns required for the armature are then given by

$$X_a = \frac{H_a}{\cdot 4\pi} L_a$$

$$X_a = \cdot 8 \, H_a \, L_a.$$

In order to avoid the coefficient ·8, it is convenient to compile, once for all, a table from the magnetisation curve in which the values of $\cdot 8 \, H_a$ and $\mathfrak{B}_a$ are inserted. We have then only to refer to the table and find the number with which the mean length of the lines through the armature must be multiplied to give X_a. In other words, the numbers of the table give the ampere-turns per centimetre of the path which the lines take through the armature.

The following two tables (one for G.G.S., and the other for English measure) may be used when the armature core is composed of best charcoal iron discs.

Exciting Power in Ampere-turns Required per Centimetre and per Inch of Armature Path.

C.G.S. Measure.		English Measure.	
$\mathfrak{B}$.	$\frac{X_a}{L_a}$	B.	$\frac{X_a}{L_a}$
5,000	1·80	5	4·25
10,000	3·60	10	8·5
11,000	4·40	11	9·5
12,000	5·83	12	11·3
13,000	8·40	[illegible]	[illegible]
13,500	10·40	13·5	18·2
14,000	12·96	14	21·3
14,500	17·60	14·5	[illegible]
15,000	22·40	[illegible]	32·4
15,500	30·50	15·5	42 5
16,000	[illegible]	16	55·7
16,500	56	16·5	75
17,000	[illegible]	17	97
17,500	88	17·5	130
18,000	[illegible]	[illegible]	[illegible]
18,500	128	18·5	[illegible]
19,000	160	19	240
19,500	220	19·5	285
20,000	280	20	350
—	—	20·5	450
—	—	21	570
—	—	21·5	710
—	—	22	1,000

The use of these tables can best be explained by an example. Say that in the armature shown in Fig. 66 the average length of path is L_a = 11in., and that we desire to have an induction of B = 16·5. By referring to the table we find that 75 ampere-turns are required per inch of path, so that out of the total exciting power applied to the field magnets 11 × 75 = 825 ampere-turns will be required for producing the flux through the armature.

To determine that part of the exciting power which is required to drive the flux through the air space, we use formulas (35) and (36). The dimensions of the polar surfaces we take from the drawing of the machine, but it is important to note that the average area through which the flux passes is slightly larger than the polar area, since the flux spreads out into a fringe at the corners of the pole-pieces, as shown to an enlarged scale to the right of Fig. 66. In practice it is generally assumed that the total width of fringe may be taken as equal to the air space, and if λ is the length of the polar area, and l the length of the armature, the mean area of interpolar space is

$$A_a = l\,(\lambda + \delta). \quad . \quad . \quad . \quad . \quad (37)$$

The average induction in that space is

$$\mathfrak{B}_a = \frac{F_a}{A_a} \quad . \quad . \quad . \quad . \quad . \quad . \quad (38)$$

and the exciting power for the air space is

$$X = \cdot 8 \, \mathfrak{B}_a \, 2\,\delta \text{ and } X = 1{,}880 \, B_a \, 2\,\delta \quad . \quad . \quad (39)$$

There remains yet the determination of the exciting power required for the magnets, including pole-pieces and yoke. Here we are met by the difficulty that on account of magnetic leakage the flux is not the same in the different parts of the magnet circuit, and that the law according to which it varies is not accurately known.

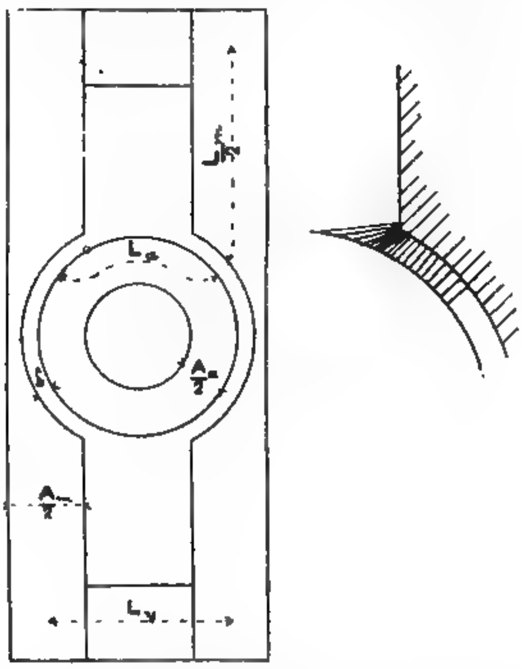


Fig. 66.

In Fig. 67 the leakage is roughly represented by dotted lines, but only those paths are shown which lie in the plane of the paper. In addition there are, of course, leakage lines between the side faces of the poles and between these and the yokes which come out of the plane of the paper in various directions, the whole machine being surrounded with a kind of magnetic halo. An attempt has been made by Prof. Forbes* to determine the leakage by assuming certain paths and integrating the flux over the various surfaces of the machine, but as in applying his methods a great deal must depend on the personal judgment of the calculator, it is generally found more accurate to calculate the leakage of a new machine from the experimental results previously obtained with machines of a similar type but of different size. Such experiments are easily performed. Referring to Fig. 67, we may assume with tolerable certainty that the flux will be a maximum at M, being in the middle of the excited part of the magnet circuit, and a minimum at A in the armature. We need then only place exploring coils round the magnet and armature in the two positions, and connect them with a ballistic galvanometer. We note the deflections on making and breaking the exciting circuit, and determine thus the total flux in these two points and their ratio. As a further check, we can couple the two exploring coils in series, and by reversing the connections determine $F_a + F_m$

* *Journal*, Society of Telegraph Engineers, xv., 551, 1886.

and $F_m - F_a$. Mr. Esson has published leakage tests made with various machines,* and has found that the ratio F_m F_a varies from 1 3 to 2. The leakage is thus represented for each type of machine as a coefficient, but such a way of representation cannot be correct for all cases, as will be seen from the following consideration. Suppose we have found a certain leakage coefficient when testing a machine with a moderately strong field. The same coefficient cannot possibly be right for the same machine if excited to a higher degree. Let us assume that we excite the machine so as to get 30 per cent more flux through the armature. The ampere-turns required for the air space have now increased by 30 per cent, but those required for the armature have increased by more than 30 per cent., so that the total magnetic pressure forcing leakage lines out of the pole pieces has increased in a greater ratio than the flux, and for this reason the leakage coefficient will now be higher. It is therefore more accurate to determine the leakage field not as a function of the total field, but as a function of the exciting power, $X_a + X_e$, actually applied to the armature. Since the leakage takes place through air, for which $\mu = 1$, the magnetic resistance of the leakage paths is constant, and we can find the total waste field, $\xi = Z_m - Z_a$ by simply dividing the armature exciting power by the magnetic resistance, ρ, of the leakage paths

$$\xi = \frac{X_a + X_e}{\rho}.$$

The coefficient ρ depends, of course, on the size and general configuration of the machine. A machine with

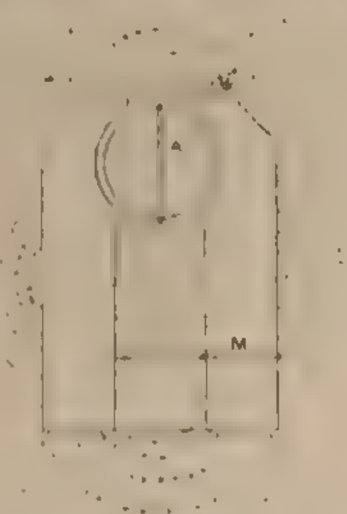


Fig. 60.

large exposed poles will naturally have a smaller ρ than one in which the poles are small. Thus Fig. 57b will have more waste field than 57d, the latter will have more than 57c, and this will have more than Fig. 59. Again, if we invert 57c so that the poles come near the bed-plate, the leakage will also increase.

We have now to consider what influence the size of a machine has on the leakage resistance ρ. By doubling the linear dimensions we quadruple the surfaces from which the leakage takes place, but at the same time we double the average length of the leakage paths so that the total leakage resistance will be halved. The leakage resistance for two machines of the same type will, therefore, vary inversely as the linear dimensions. A convenient way of stating the linear dimensions of a machine is to give the size of its armature, and in order to permit of slight variations in the ratio of length and diameter of armature, we may conveniently state the linear dimensions of the machine, not in terms of either the diameter or the length of the armature, but in terms of the square root of their product. The leakage resistance will then be given by the expression

$$\rho = \frac{K}{\sqrt{l\,d}} \qquad (10)$$

where l and d are the length and diameter of the armature core, and K is a coefficient depending on the type of the machine, but not on its size.

In overtype machines K may be taken at ·3 in C.G.S., and 680 in English measure, and in undertype machines at ·21 and 460 respectively. By adding the leakage lines to the useful flux we find the total flux through the magnets, and therefore the induction. To find the corresponding exciting power we proceed in the same way as with the armature, by the use of a table giving ampere-turns per centimetre or per inch as a function of the induction. There is, however, this difference, that an error in the estimation of the permeability of the armature core is not of very great importance, the exciting power required for the armature being, as a rule, comparatively small, whereas an error in the estimation of the permeability of the field magnets may be of great importance, as it affects a much larger part of the total exciting power. The difference in the permeability between various samples of iron is generally greater for high than for low inductions, so that if for constructive reasons we are compelled to work at a high induction in the field magnets, it becomes all the more important to test the magnetic properties of the particular brand of iron employed. On the other hand, there is less danger of error if we work with a moderate induction, a course which we would adopt wherever possible with a view to economise exciting wire. In such case the exciting power required for the magnets is relatively smaller, and an error in this smaller quantity is of less importance—to say nothing of the fact that the error itself is not so likely to occur. In ordinary work we may, therefore, neglect to test a sample of the metal in each case, and use a table of 𝕭 and $\frac{X}{L}$ prepared, once for all, from tests made with iron of average quality. The usual materials for field magnets are wrought iron, cast steel, and cast iron. The latter should be only employed for those parts of the circuit which are not surrounded by exciting wire, such as yokes and pole pieces, because, otherwise, the cost of copper owing to the large sections of iron surrounded by wire becomes too great. Wrought iron and mild cast steel are generally used for the magnet cores proper, and are about equivalent, magnetically.

Exciting Power in Ampere-turns Required per Centimetre and per Inch of Path through Wrought Iron.

C.G.S. Measure.				English Measure.			
𝕭	$\frac{X_m}{L_m}$	𝕭	$\frac{X_m}{L_m}$	B.	$\frac{X_m}{L_m}$	B.	[illegible]
5,000	1 92	16,100	60 0	6	4 85	16 1	[illegible]
10 000	4 25	16 200	63 5	10	9·7	16 3	[illegible]
11,000	5 2	16,300	67 2	11	11 3	16 5	[illegible]
11 500	5 91	16 400	71 0	11 5	12 3	[illegible]	[illegible]
12,000	6 8	16,500	76	12	13 43	[illegible]	[illegible]
12,500	7 64	16 600	81	12 5	15 2	[illegible]	[illegible]
12 750	8 47	16,700	86	13 0	17 2	[illegible]	[illegible]
13,000	9 27	16 800	91	13 2	18 4	[illegible]	[illegible]
13 200	10 12	16,900	97	13 4	19 3	[illegible]	[illegible]
13,400	11·08	17,000	103	13 6	20 6	17	[illegible]
13 600	12 1	17,100	112	13 8	22	17 1	[illegible]
13,800	13 5	17 200	130	14	23 5	17 2	[illegible]
14 000	15 1	17,300	150	14 2	25 5	17 3	[illegible]
14 200	17 2	17,400	[illegible]	14 4	27 [illegible]	[illegible]	[illegible]
14 400	19 3	17 500	[illegible]	14 6	30 5	[illegible]	[illegible]
14 600	22 3			14 8	[illegible]	[illegible]	[illegible]
[illegible]	25 6	–		15	37 5	[illegible]	[illegible]
15 000	29 7	–	–	15 2	[illegible]	[illegible]	[illegible]
15 200	34 3			15 4	46 8	[illegible]	[illegible]
15 400	39 [illegible]			15 6	54	[illegible]	[illegible]
15 600	44 4			15 8	61 5	[illegible]	[illegible]
15 800	50 3		—	16	70	[illegible]	[illegible]
16,000	56 0		-	-		[illegible]	[illegible]
						[illegible]	[illegible]
	-					[illegible]	[illegible]
-			-		-	[illegible]	[illegible]
	-	-	-		-	[illegible]	[illegible]

Out of 13 samples of cast steel which I tested in the magnetometer, three only were of sensibly lower permeability than ordinary wrought iron as used for cases

* Journal Inst. Electrical Engineers, xix., 122, 1890.

the nearest number of B is 5, to which correspond 4·85 ampere-turns per inch of path Interpolating, we find that to B = 5·10 correspond 4·95 ampere turns, and as the average length of path of the lines through magnets and yoke is 66in., the magnet exciting power is

$$X_m = 4·95 \times 66 = 326.$$

We now find the total exciting power by adding up its component parts. Thus:

The armature core requires	85	ampere turns
The air spaces require	5,042	,,
The magnets require	326	,,
Total	5,453	,,

The calculation here explained gives us, incidentally, also the leakage coefficient, but only for the particular flux of 500 lines. We have seen that 163 lines are wasted over and above the 500 utilised. The percentage of waste is therefore 163/500 = 32·6 per cent., and the leakage coefficient is 1·326.

To find other points on the characteristic, we repeat the calculations, assuming a flux of, say, 800, 1,000, 1,100, 1,200, 1,300, 1,400, 1,500, 1,600, and 1,650 lines. These calculations may be conveniently made in tabular form, so that clerical errors may be more easily detected and labour economised. At the head of the table we write the constructive data of the machine to facilitate reference.

$A_c = 80$ $A_a = 335$ $A_m = 130$ $\rho = 31·5$
$L_c = 16$ $\delta = ·9$ $L = 66$ $2\delta\,1,880 = 3,384$

Z_a ξ Z_m	B_c B_a B_m	X_c X_a —	— $X_c + X_a$ X_m	— — X
500 163 663	6·25 [illegible] 5·10	8·5 504·2 	— 5,127 326	— — [illegible]
800 261 1,061	10 2·385 8·17	136 8,100 —	— 8,236 543	— — 8,779
1,000 328 1,328	12·5 2·98 10·20	210 10,100 —	 10,310 680	— 10,990
1,100 364 1,464	13·75 3·29 11·23	313 11,150 	 11,463 780	 12,243
1,200 402 1,602	15 3·58 12·31	515 12,150 —	 12,665 942	— — 13,607
1,300 [illegible] 1,748	[illegible] 3·83 13·44	1,000 13,150 —	— 14,150 1,290	- 15,440
1,400 516 1,916	17·50 4·18 14·7	2,075 14,170 —	— 16,245 [illegible]	— — 18,315
1,500 594 2,094	[illegible] 4·48 16·1	3,520 15,200 -	— 18,720 4,880	— — 23,600
1,600 691 2,291	20 4·775 17·6	5,600 16,200 	 21,800 11,550	— 33,350
1,650 [illegible] 2,420	20·6 4·92 [illegible]	7,600 16,650 -	— 24,250 21,300	— - 45,550

If we now determine the leakage coefficient for a flux of 1,500 lines we find it to have risen to 1 + 594/1,500 = 1·394 For Z = 1,600 it is still greater—namely, 1 + 691/1,600 = 1·432, whilst the initial value was only 1·326 It will be thus be seen that the leakage coefficient can only give the approximate value of the waste field. Fig. 68 shows the characteristic as plotted from the above table. By the use of this curve we can at once read off the exciting power required to produce any desired flux through the armature within the limits of its capacity to pass the flux. The E.M.F. produced being proportional to the flux and the speed, we see that the curve, by suitab[ly ...] the scale of ordinates, may also be used to repre[sent the] E.M.F on open circit for constant speed as a fun[ction of] the exciting power. It is, however, important to [...] that the curve only refers to the E.M.F. on ope[n ...]

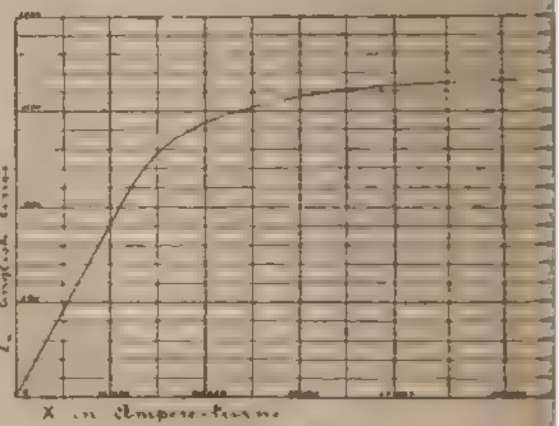


FIG. 68.

If a current is permitted to flow through the arm[ature it] produces a certain reaction on the field, and this [must be] taken into account.

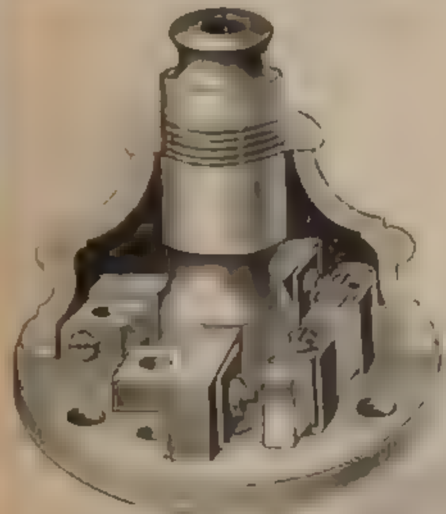
PROPOSED ELECTRICAL CONGRESS AT CH[ICAGO]

A sub-committee formed of Prof. Ayrton, F R S , P[rof.] Thompson, F R S , and Major-General Webber, C B M I C E , has issued a report to the committee of [the elec]trical section After a brief historical account of [the] Congress of 1881, the report continues

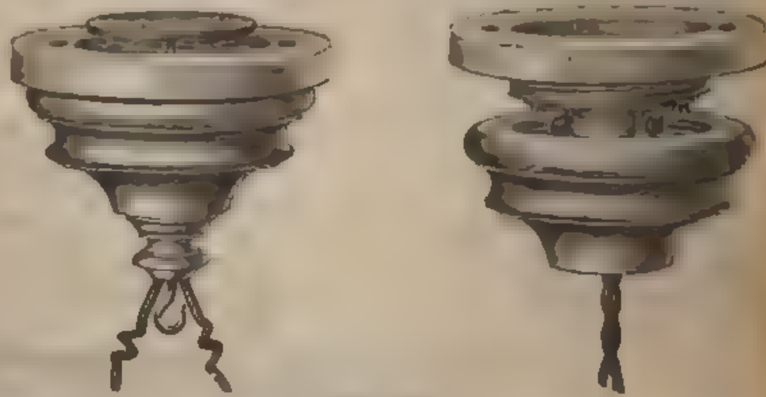
Subjects on some of which it is proposed that al[so] suggestive special papers might be read by specially [...] members Comparison between procedure in [...] countries. Methods of avoiding electrical interfere[nce ...] risks to person and property. Units of magnetis[m] and mode of embodying them in concrete standard[s ...] adoption of the name "Henry" for the unit of self and [...] induction. Adoption of the "kilowatt" instead of the "[...] power" as the unit of power. International name[s] for describing phenomena of alternate currents [...] electromagnetic waves. National and municipal [...] laboratories. Materials for standards of electric [...] Points of difference of the electrical vocabulary used in [...] countries. The direct conversion of the energy of [...] electric energy. Comparison of the various methods [...] for the electric transmission of power. The cost of [...] in relation to high pressure for the electric transmi[ssion of] power. Comparison of the economics of the various [...] of electric distribution. Alternate current motors Th[e beha]viour of transformers when supplying power to alternate [...] motors. The construction of condensers for alternate [...] purposes. The measurement of power in polyphase [...] Direct coupled and not direct coupled dynamos The [...] equalising dynamos in a three and a five wire system [...] of accumulators in central stations The proportions [...] output of dynamos and the weight of copper and [...] ployed in their construction. Electric traction Ap[plication] of electric power in mining. The adoption of a [...] method of distinguishing positive and negative [...] Electric supply meters American, British, Con[tinental]. Criterion of sensibility of galvanometers Commercial [instru]ments for measurement of electric quantities The [...] between the voltage of the arc and the quality a[nd] position of the carbons The ageing of incandescent [...] The electric working of metals. The use of elect[ro]magnetic tests for ascertaining the mechanical prop[erties of] metals and alloys. The best material and mode of ere[cting] lightning conductors in the light of recent researches in [...] discharges The prospecting for iron by magnetic [...] International telegraphy Fast speed and long-distance [tele]graphy The use of batteries or other generators for te[...] Telegraphic lines, land and sea Harmonic te[...] Writing telegraphs Long-distance telephony The p[...] of providing telephonic communication without wires [...] cation of electric signalling to the working of railways ([...] time, etc), and to naval and military purposes M[...] separators The use of electricity in engraving and reproductions.

The committee suggest that it would be desirable [...] selection should be made as soon as possible, by the A[...]

desired. The same cut-outs are made in conjunction with other fittings, such as switches or ceiling roses. One of the illustrations shows an improved form of ceiling rose with centre support to carry the weight of an electrolier. It has raised sectional bars of china on the base with removable

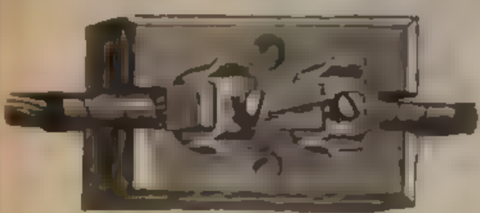


Ceiling Rose with Bar Cut-Out

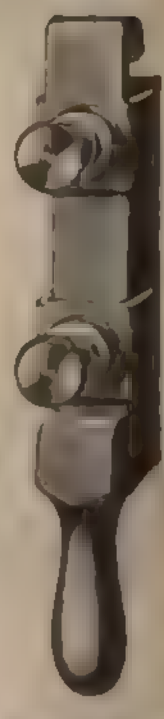


Ceiling Roses

Lever Bar Switch Cut-Outs



China Bar Cut-Outs

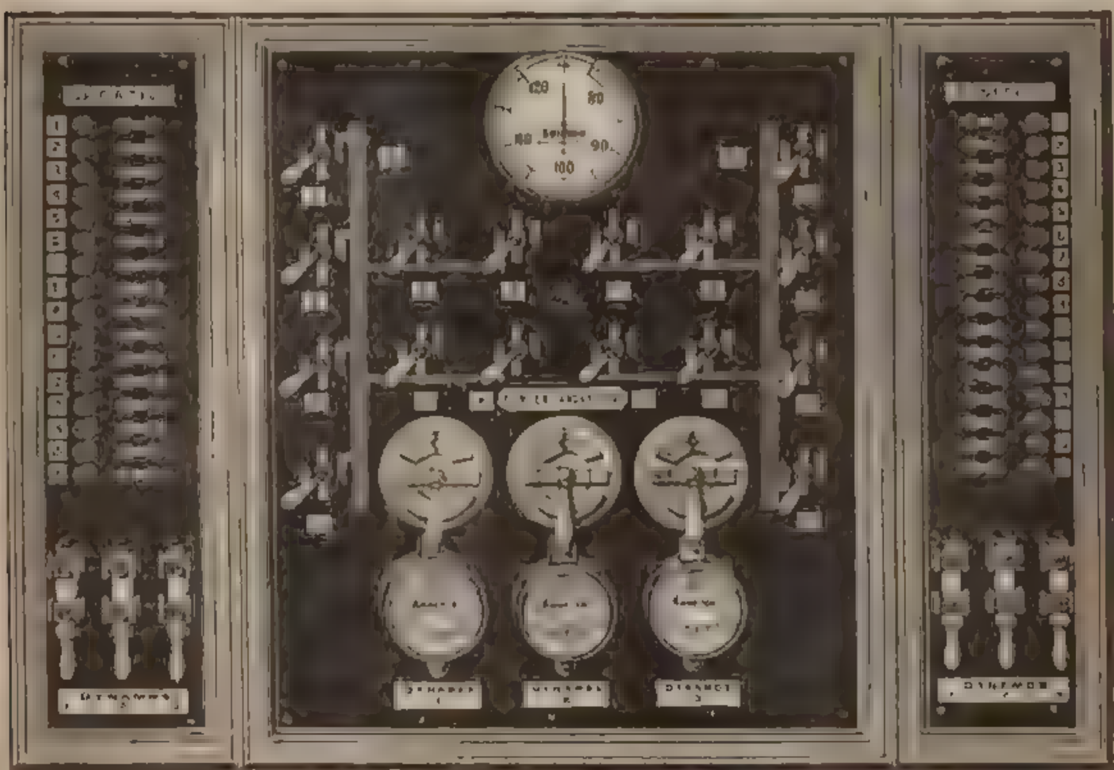


bar cut-out, and the cap is fastened by a screw collar. Other types of screw-covered ceiling roses are made, with or without a central hook for taking the weight of the lamp. The ornamental switches for houses are made in a great variety of very handsome designs, the floral decoration of cream china in harmonious shades touched with gold being favourite forms.

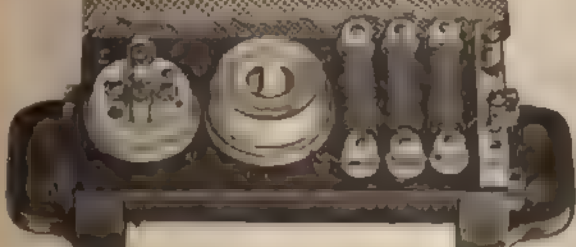
The accompanying illustration is reproduced from a photograph of the main switchboard erected at the new post office at Birmingham. The board is of slate, enamelled black, measuring 7ft. 6in. by 5ft. 4in., enclosed in an oak frame, and mounted on substantial supports. The mains from three dynamos are led to the lever switch cut-outs on the right, the current then passing to the ammeters and main switches. These latter are designed to carry 100

amperes, and consist of massive gunmetal castings mounted on heavy slabs of porcelain. These are two-way switches, so that the current from any dynamo may be sent to either set of eight branch switches, but by inserting a plug between the contact-pieces of any switch, the current is distributed to all the 16 branches. The arrangement has been found of the greatest advantage in changing over, as lamp on an incandescent circuit. A patent extra-rapid double-pole main switch is also illustrated, of somewhat peculiar make. Two discs of hard fibre carry a pair of semi-circular brass plates, and revolve under the action of a powerful steel spring. This is released by the action of the ratchet handle, and the movement is so rapid that it cannot be followed by the eye. There are a

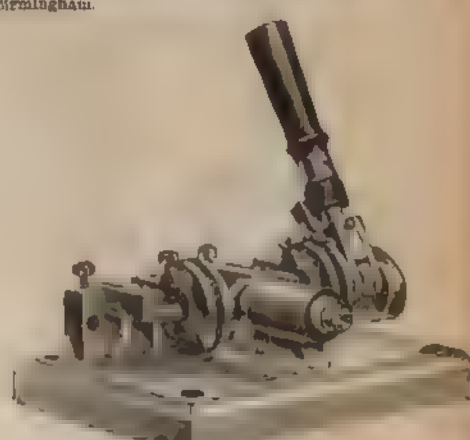
Ornamental Screw [illegible] Switches.



Dynamo Switchboard, made for the New Post Office, Birmingham.



Switch, Fuse, and Resistance.



Extra Rapid Break Switch.

the load may be transferred to another dynamo in two stages. From the 16 switches the current travels to the positive cut-outs on the right, thence to the distributing switchboards on different floors in the building, returning to the negative cut-outs on the left, and, finally, through the negative main lever switch fuses back to the dynamo.

A very convenient piece of apparatus is a bar fuse, switch, and resistance frame on one base for an arc large variety of other china fittings made by Messrs. Fowler and Lancaster too numerous for us here to illustrate, especially among counterweight pendants, roses, wall contacts, and some neat and effective forms of lamp holders. For these we must refer readers to the descriptions published, issued from their works at Graham-street, Birmingham, in which the china fittings are fully illustrated.

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CONTENTS.

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ELECTRICITY AND RAILWAY MANAGEMENT.

The short days of winter and the great amount of travelling necessary for all business men, bring prominently forward the question of lighting and heating our trains. It is usual to contend that only long distance trains need consideration, but we maintain that as much attention should be given to the comfort of the suburban passenger as to the comfort of the long-distance passenger. A very large proportion of the illness in the winter season is caused by the disgraceful and condemnable system of railway management. Thousands of men and women daily leave warm homes and offices to walk to the station. Physically, on arriving at the station, they are in the best of health, and comfortably warm. But something has delayed the train, and in the majority of cases they have to wait on a wind-swept platform without a chance of shelter, thereby incurring the danger of a chill. Even if the train is, as the Americans say, "on time," the compartment into which they are hurried is several degrees lower in temperature than the rooms which they have left, and often we hear the remark, "Yes, I caught it—the cold—in the train." Travelling in winter in and around big towns is a dangerous pastime, especially in the evening, when a large part of mankind has not dined and is physically weaker to resist the effects of cold. So much for the lack of heat. The lack of light is perhaps less dangerous to health, but more active upon temper. If we have to wait about in railway stations and in trains, surely plenty of light might be provided. Specialists say reading in trains is bad for the eyes; lots of things are bad for health; but custom is strong, and reading in trains is common. It is ten thousand times worse for the eyes to read in a bad light than in a good one. The oil lamps provided deserve cursing instead of blessing; they serve not as aids to while away the time, only as aids to get into and out of carriages without knocking against the other occupants of the carriage. Here and there the railway companies have installed a better light. Some of them use gas, and turn it down as low as they can, while able to say it is a light. Others, and by far the greater number of trains, use oil with lamps that, either by means of a layer of oil which has escaped, or owing to construction, prevent more than a fraction of the light reaching the occupants of the carriage. Latterly, a few trains on some of the more progressive lines have been fitted electrically.

The whole question is said to be one of cost. This might be denied with a fair amount of accuracy, but we prefer to argue it on other lines. Travellers of a quarter of a century ago could tell a doleful tale of the management of some of the lines which at the present day are conducted upon different principles. Then everything was bad—the share quotations worse than all. Then, as now, the pessimists said, We cannot do this, we cannot do that; look at the cost, and we really have not got the money. Well, the pessimists were sent to Coventry, or some other place, where their moanings had no effect, and enlightened men began to

view of showing that, contrary to the general supposition, it is the employés—the staff—who reap the profits, and only in a few cases do the proprietors or shareholders of the concern employing them.

If anyone will take the trouble to examine the question, it will be found that, with rare exceptions, it is the old, long established businesses that are reaping profits, where profits are made. Businesses whose conductors, after weathering the storms of their early days, have learned not to go in for heroics, not to touch work that will not pay, except for very special reasons, such as a very certain road to a very profitable deal. They have learnt to examine carefully every project which comes before them, and to count the cost to its utmost, not to go into it blindfold because there was a taking look about it. They have learnt, too, that a certain rate of profit must be obtained if their businesses are to be a success, and will not be induced by the roseate views of any middleman to lower their prices below their working standard. They have learnt also, probably from bitter experience, that under the very ablest management their working expenses must be heavy. The very march of science, and the improvements that are constantly being made in electrical apparatus, render the expenses of the electrical engineer heavier, whether he be manufacturer or contractor, or both. Some new discovery may render a lot of apparatus worth only its value as old metal. There have been numerous instances of this within the last 10 years. The career of the alternator, for instance, affords a striking example.

After the first Paris Electrical Exhibition, when the Jablochkoff candle was thought to have solved the problem of electric lighting, and when even arc lamps of the ordinary type were being arranged to run with alternate currents, alternators were all the rage. Even so able a man as the late Count du Moncel, in reporting on the recently invented De Meriten's machine, referred to the fact that it was an alternator, as distinctly in its favour. Much capital was expended in developing alternators, and many different types were brought out, few of which are to be seen to-day. A short while after the alternator, in its then form, was a drug on the market. Later on, after the invention of the incandescent lamp, it came to the front again, but in quite another form, and again disappeared, and this after very large sums had been expended on it. Very few alternators of this second period are now working, they having been displaced by the compound machine. At any rate it would be a difficult matter to sell one to-day. Now the alternator is in the field again, but in yet another form as far as the manufacturer is concerned.

Anyone who held alternators at either of these periods when their sale closed, would have lost heavily on them. In all these cases it is the manufacturer or contractor who loses, not the engineer. The latter receives his salary as long as his employers have any money to go on with, and usually gets full credit for whatever he may have done, so that if he is really an able man he has usually not much difficulty in getting another appointment. The writer wishes it clearly to be understood that he in no wise underrates the services of engineers. But for their skill and ability the work usually could not go forward at all, and, again, they are able to reduce the losses made or to increase profits, when they do come, by that same skill and ability. What the writer wishes to do in this article, is to disabuse the minds of many engineers of the idea that they are not being fairly dealt with by employers, whom they think are taking the results of their labour and giving them short commons in return. He would also like to dissuade them from the idea that is constantly before many of them that they will do much better in business for themselves, and with that view save from their salaries, with a view of taking the first opportunity of becoming their own masters. The money that has been fairly earned, and perhaps represents years of careful living—perhaps accompanied by many privations—is too often lost in a few months by the possessor having been tempted into a "good thing." Once the money is locked up in machinery, or in a connection, for practical purposes it is gone. The owner of the machinery must stick to it like the galley slave to his oar, or a far harder taskmaster than the galley driver will soon be down upon him.

As an engineer simply, with a good know[ledge of his] work, he can go where he likes, his brain[s are] worth their market value, where the machinery [he may] have bought with the earlier fruit of them may [have to be] sold for old metal. The fortunes that have [been made,] except in cases where special circumstances have [helped,] have been made either by persistent, never tiring [work] continued over a very long period, or by some [clever] finance—some lucky speculation. It need hardly [be men]tioned here that speculation is not business, [accord]ing G. Sims's witty definition of business. A[nd] speculation is a very dangerous game for an e[ngineer to] play. Few men ultimately reap success from [it,] and the man whom Nature has intended for [an engineer] has smaller chance than anyone.

Men, too, who ought to know better, o[ften cry out] against the price charged for electrical appara[tus. They] estimate, sometimes correctly and sometimes [not, what] the cost of construction should be, and they [add what] they consider ought to be a fair profit on it, and [this] is what in their opinion the price of the article [should be.] Anything which is charged above they consi[der extortion,] and if the article happens to be one essent[ial to a par]ticular branch of the industry, they declaim th[at the price] is stopping its development.

The writer remembers an engineer telling h[im] of a particular branch of business. "We put on [...] for general charges and 25 per cent. for pro[fit," said the] writer's friend, "and we lost money." The ex[planation of] this was, of course, that the whole amount, an[d] more, was swallowed up in working expenses. [The writer] was pleased to find that the Electrical Se[ction of the] London Chamber of Commerce were discussing [the question] of cutting tenders for contracts, and he trusts [some]thing may be done to reduce that evil. He w[ould cite] another case similar. Edison Swan lamps, as is [well known,] are sold to the trade at a certain price, less a d[iscount. As] the trade seller has to pay carriage, to pay for t[he] empties and for breakages, this discount is ofte[n] absorbed; and under favourable circumstances [leaves] a very small margin. Yet there are many [in the] trade supplying lamps at a discount off the pu[blic price] and paying all these charges.

The writer would ask, Is there any reason [why] the consumer with this amount? or is it a su[fficient reward] for all the trouble of dealing with the party [and keeping] the account, that you have deprived someone [else of the] honour of doing so?

Is it not time that manufacturers and oth[ers ceased to] make handsome presents to consumers in the f[orm of discounts] to keep others out of the field? Will, also, e[ngineers in]tending to go into business for themselves be w[ise? Of] course they will not; they do no good to the[mselves;] they not only lose the money they embark in [the "good] thing," but they decrease the fund from which [their] salaries are paid, and so doubly injure themselv[es.]

ECONOMIC POSSIBILITIES OF THE GE[NERATION] OF E.M.F. IN THE COALFIELDS, [AND ITS] APPLICATION TO INDUSTRIAL CENTR[ES.*]

BY R. B. THWAITE, C.E.

(Concluded from page [...])

APPENDIX.

Specification of [...] h.p. Electric Power Transm[ission from] the Yorkshire Coalfields to the Metropolis [...] (1[...] miles).

C. E. L. Brown, of Brown, Boveri, [...]

Power Generating Plant.—Twenty Otto [...] 500 h.p. to 600 h.p. each, arranged so that when [...] working at their maximum load, and the whole [...] required, there are still three engines in reserve [...] to be 180 revolutions.

Electric Generating Plant.—Twenty triphase alt[ernate cur]rent machines, each for 600 h.p., together with [trans]formers, for stepping up the current to [...] generating machines would be regulated by [...] governors, and so arranged that there is one [...] electric generating machine capable of governing [...]

* Paper read before the Manchester Association of [...]

to 273 h.p. The magnet wheel of alternator is 7·2ft. diameter, and contains 30 poles. The smaller 50 h.p. turbines are coupled direct to a four-pole exciter running at 375 revolutions per minute, providing a current of 150 amperes at 180 volts E.M.F. The exciters are arranged in parallel, and they are equipped with hand rheostats. The regulation is effected by two automatic rheostats, of the Blathy type, in the field circuit of the exciting machines. These rheostats are so arranged that the E.M.F. of the 16 transformers working in parallel form a group that transforms the 5,000 volts pressure current into one of 2,000 volts, and transmits the current from the Tivoli aerial conductors to the underground network of conductor cables that distribute the electric energy throughout the streets of Rome. The effect of loss in the line is balanced by an equaliser. Switching out the main, and breaking the circuit is effected by the use of a load resistance rheostat, composed of 87 miles of iron wire. The transmission conductors consist of four copper cables of 19 wires each. The cables are so arranged that they can be exchanged at will in the event of accident, or when repairs are necessary. Three of the cables are sufficient for conveying the total energy of the generating station. Two wires carry two thirds of the load. The total efficiency is 80 per cent., or a loss of 20 per cent., the exact loss being stated to be 1,020 volts out of an initial pressure of 5,100 volts. The transmission cables are attached to very strong oil insulators, placed upon iron and wood poles erected at distances of 115ft. to 130ft. apart. The same line of poles carries a dozen bronze wires for telegraphic and telephonic purposes. The lowest cable is 25ft. above the ground. The central station in Rome, 18⅓ miles from Tivoli, is operated at a pressure of 2,000 volts, the Tivolian potential energy being reduced to this pressure by cable resistance, and 32 transformers, each of 25,000 watts capacity. At present 250 arc lights are in use, but this number can be increased up to 600. These lights are arranged in series of 45 each, the conductor aerial lines being of copper wire, four millimetres in diameter. Each large step-down transformer provides a current of 14 amperes at 2,000 volts for each group of 45 arc lights. Fourteen such transformers feed 14 arc light circuits, or 630 lamps. In each of these circuits the automatic rheostats establish a constant-current potential of 14 amperes.

The Cost of Electric Motor Generators Compared with that of Steam and Gas Engines.

It may be interesting and useful to compare the relative cost of the three methods of generating power—that is, with a steam engine, a gas engine, and an electric motor—from the point of view of the consumer, and based on German practice as interpreted by Prof. Salomon and Herr Redner.

In German small power steam engine practice of the non-condensing type, four kilos. of coal are absorbed per indicated horse-power—that is 8·80lb., and for the larger powers the average may be taken at 2½ kilos., or 5·50lb. per indicated horse-power per hour. Working 1,800 hours per annum, and using town's lighting gas for driving gas motor, it is found that up to 15 i.h.p., driven with this comparatively costly gas, gas engine power is the cheapest; but the margin of advantage gradually falls until for 25 i.h.p. it disappears, and is then only equal to steam; but where the time worked is 3,000 hours per annum, the gas engine is the cheapest form of motor generator all along the line. With electrically conveyed dynamic energy, the absorption of work need only be in proportion to work done, whereas with the steam engine the full load is always on. Herr Redner has established the cost of completely installing a line of motors varying in power from 1 h.p. to 25 h.p. It may be stated that the cost exceeds English practice, but the ratios are, however, usefully comparable.

Power of Motor.

	H.P. 1	H.P. 10	H.P. 15	H.P. 25
Steam engine—				
Marks	1550—£75·9.	M6800—£333.	M8300—£406.	M12000—£636
Gas motors—				
Marks	1810—£88·6	M6300—£308.	M8200—£401.	M10200—£501
Electric motors—				
Marks	650—£31·8	M2100—£102	M2520—£123	M3980—£195

In the cost of maintenance, including the yearly expense involved in repairs, interest, and amortisation, the electric motor generator is very much less than either that of steam or gas. Here are Herr Redner's figures:—

Motive Power.

	H.P. 1	H.P. 10	H.P. 15	H.P. 25
Steam engine—				
Marks	242·50—£11·88	M1020—£49	M1215—£60·9	M1800—£88
Gas motors—				
Marks	271·60—£13·3	M945—£46	M1230—£60	M1530—£75
Electric motor generators—				
Marks	105·14—£5·14	M350—£17·1	M440—£21·5	M575—£28

Herr Prof. Salomon is of opinion that for steam engines 5 per cent. should be allowed for interest, 8 to 9 per cent. for depreciation, and 1 to 3 per cent. for repairs.

It may be noted here that at Bockenheim the electric motors are hired out. The relative portable character of the electric motor and generator lends itself admirably for the convenient and often economically advantageous hiring out system.

Electric Traction.

One of the industrial applications that awaits fuller development is that of heavy electric traction for high speeds and long distances, and whilst locomotives with electric propelling gear are being built in both America and Europe of equal tractive power to an ordinary passenger steam-driven locomotive, a practical progressive step in the development of the application of energy exists in the South London electric railway. The ... of this underground addition to the metropolitan railway ... has removed any possible objections that could have ... against practicable electrically propelled locomotives ... exception of a few negligible minor difficulties, the ... has been a solid success, both financially, hygienically ... thermo-dynamical—the latter efficiency is 300 per ... than the ordinary locomotive practice. The following ... factors of experience in this application:

Running speed per hour, 13·25 miles.
Mean amperes from Stockwell to City ...
Do. volts do. do. ...
Mean amperes from City to Stockwell ...
Do. volts do. do. ...
Running speed per hour, 12·7 miles.

In these electric locomotives the armature coils ... directly on to the axles of the locomotive wheels, ... motives built by Messrs. Beyer, Peacock, and Co., ... chester, weigh 13½ tons. The original conception of ... method of driving is traceable to Sir W. Siemens ... currents are collected from a central rail by means ... contact shoe, fitted at each end of locomotive. ... torque, or starting energy, is 140 amperes.

Ordinary train driving by electric energy is in ... in the United States, and in its overhead conductor ... efficiency is said to be satisfactory. The same principle ... adopted by the Liverpool Overhead Railway. Underground ... electric traction is now successfully employed in ... Europe and America, and offers great advantages ... systems. The same principle of dynamic transmission ... for winding purposes. The traction of canal boats ... development to bring a wanted stimulus to this ... method of transmitting cargo.

The Financial Risk Involved in Laying Down Long ... Electric Conductors.

It will be recognised that for long-distance lines of ... the cost of installation and plant is made up in a very ... proportion by the electric conductor mains. Hence ... tion of the risk of value depreciation of this property ... class importance. Fortunately, the bulk of the ... purchase of a character of conductor metal that ... element in our coinage, and is of such a character that ... to ordinary atmospheric or subterraneous conditions, ... gas or water pipes, it suffers very little, if indeed any ... depreciation. The copper will weigh as much at the ... term of 20 years as when originally laid down. The ... portion associated with this element is practically ... question arises: What is the fair rate of interest that ... charged on an element possessing such a high degree of ... security?

To answer this with adequacy of response, we ... examine the extent of the fluctuations of the price ... the last 10 years, in which period, owing to the ... sion of its use, a rare degree of variation of demand ... Copper leads or wire purchased at a falling value ... line of average value may have a possible depreciation ... of 2·5 in 7, equal to 36 per cent. of its par value ... average ratio of risk can now be compared with those of ... rate of interest, that of the railway ordinary stock and ... ment stock. In the research fixing these latter rates ... is indebted to the kindness of the editor of the ... He writes that in the 10 years ending 1891 the bank rate ... from 2 to 6 per cent., the average rate being perhaps ... On railway ordinary stock the average return at the ... quotations was about 3½ per cent., and during this ... the average Government return was about 2¾ per cent. ... adding these rates of interest together and striking a ... we obtain the figure 3⅔ per cent. This rate, the author ... would be a fair rate of interest for the class of ... sented by large weights of copper conductors. The author ... ventures to suggest that the part of the capital, ... cover the cost of trunk transmission lines should be ... the special issue of mortgage debentures at the rate ... stipulated.

American Steam Engine High Power—Latest Practice ... Station Work.

The author is favoured with the following particulars ... the latest steam high power practice from Messrs. E. P. ... Co., Reliance Works, Milwaukee, Wisconsin. The ... horse power West End Street Railway Station at ... is equipped with eight triple expansion condensing engines ... cylinders 23in., 36in., and 52in. diameter by ... stroke ... triple expansion condensing engine, having cylinders ... and ...in. diameter by 48in. stroke. The larger ... at 1,000 h.p. under normal conditions, and the smaller ... 600 h.p. All steam cylinders are steam jacketed ... and heads, the initial system pressure is ... inch. Each engine is provided with a Wheeler Admiralty ... condenser, with air and circulating pumps operated ... pendent steam power. The flywheels for large engines ... diameter by 127in. face, and each one weighs ... engines are located in two stations, one station having ... large engines and the other station two of the large ... the smaller machine. Each set of three engines is ... shaft located in a shaft alley, and the electric ... operated from pulleys located on this line shaft. Each ...

THE LAUFFEN FRANKFORT TRANSMISSION OF ELECTRIC ENERGY (112 Miles).

HERR PROFESSOR WEBER'S RESULTS.

Received from the Maschinen-Fabrik Oerlikon Company, Oerlikon.

Date. 1891.	Turbine H P.	Efficiency electric generator (dynamo)	Actual working efficiency	The actual efficiency H.P. step up transformers.	Working efficiency per stage.	Loss of conductor H.P.	Second transformer step-down H P.	Percentage efficiency second transformer step down H.P.	Commercial working efficiency.	Net efficiency electric generating plant betw'n poles of dynamos or electric generators.	Tot. efficiency between turbine shaft and consumer terminals	State of weather
11th October	120·0	108·1	0·894	102·1	0·947	7·3	95·1	89·5	0·961	82·6	74·0	Fine and dry weather
„ „	121·1	108·3	0·894	102·6	0·947	7·6	95·0	81·4	0·941	82·4	73·8	
12th „	127·0	114·4	0·900	108·7	0·950	8·0	100·7	95·7	0·944	82·0	74·3	Dull
„ „	127·5	114·6	0·900	109·0	0·950	8·1	100·9	95·3	0·944	82·2	74·8	
„ „	99·3	86·8	0·874	81·5	0·939	5·0	76·5	71·4	0·953	82·1	71·9	
13th „	105·9	93·3	0·881	87·7	0·940	6·0	81·7	76·7	0·931	81·6	72·1	Rain.
„ „	105·9	93·3	0·881	87·7	0·940	5·9	81·8	76·1	0·934	81·7	72·2	
„ „	151·8	139·1	0·916	132·8	0·955	12·8	120·0	114·9	0·950	81·8	75·1	
14th „	151·7	139·0	0·916	132·7	[illegible]	12·5	120·2	114·2	0·950	[illegible]	[illegible]	
„ „	194·7	182·2	0·935	175·1	0·961	21·4	153·7	144·2	0·957	79·1	74·1	
„ „	197·4	184·8	0·935	177·6	0·963	25·2	152·4	145·8	0·957	78·8	73·9	Fine
„ „	117·6	104·9	0·892	99·2	0·946	7·5	91·7	86·2	0·940	82·0	73·3	
„ „	112·7	100·1	0·888	94·5	0·944	6·9	87·6	82·2	0·938	81·9	72·5	
„ „	78·2	68·1	0·845	64·1	0·925	3·1	58·0	53·5	0·922	80·2	68·5	
15th „	190·7	177·9	0·933	171·8	0·960	25·5	145·3	138·8	0·956	77·8	72·8	Rain early in the day
„ „	190·0	177·3	0·933	170·2	0·960	21·9	[illegible]	[illegible]	0·956	78·1	73·1	
„ „	189·7	177·0	0·933	169·9	0·960	24·6	145·3	138·9	0·956	78·1	73·2	

THE TRUNK LINES OF TRANSMISSION.

TABLE* SHOWING THE FLUCTUATIONS IN THE PRICE OF COPPER IN THE TEN YEARS ENDING 1892

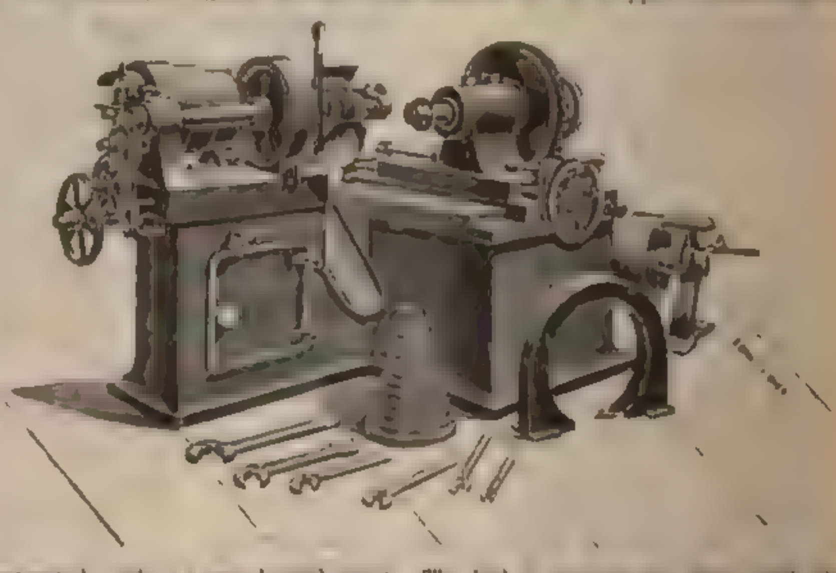
—	1883	1884.	1885.	1886.	1887.	1888.	1889.	1890	1891.	1892
January	63 0 0	56 10 0	47 15 0	40 0 0	38 17 6	77 2 6	77 10 0	48 17 6	52 12 6	44 12 6
February	65 0 0	55 7 6	47 5 0	41 0 0	40 7 6	78 17 6	78 0 0	47 0 0	52 15 0	44 5 0
March	64 15 0	53 17 6	45 5 0	41 10 0	39 10 0	80 2 6	39 5 0	47 12 6	53 2 6	46 5 0
April	62 17 6	56 10 0	43 5 0	41 7 6	39 7 6	80 2 6	37 15 0	49 2 6	51 12 6	45 12 6
May	63 15 0	56 0 0	45 2 6	39 10 0	39 5 0	80 15 0	41 0 0	54 10 0	35 5 0	46 7 6
June	64 0 0	54 2 6	44 10 0	39 12 6	40 0 0	84 0 0	41 10 0	58 10 0	55 5 0	44 17 6
July	63 12 6	53 0 0	43 10 0	38 17 6	40 0 0	80 10 0	42 0 0	57 0 0	52 0 0	44 17 6
August	64 0 0	53 17 6	42 7 6	39 7 6	40 2 6	80 0 0	43 10 0	60 5 0	52 10 0	44 7 6
September	63 0 0	54 2 6	40 15 0	41 2 6	40 15 0	100 0 0	43 0 0	59 10 0	51 2 6	44 2 6
October	[illegible] 5 0	52 12 6	39 10 0	40 7 6	44 5 0	78 5 0	44 2 6	58 7 6	46 5 0	—
November	59 10 0	51 5 0	42 7 6	39 15 0	66 15 0	77 10 0	50 2 6	55 7 6	44 12 6	
December	58 [illegible] 0	47 5 0	41 0 0	38 10 0	85 0 0	77 10 0	50 2 6	52 10 0	46 15 0	

* Prepared for the author by Messrs. H. R. Merton and Co., 2, Metal Exchange buildings, Leadenhall avenue, London.

TRADE NOTES AND NOVELTIES.

A NEW CIRCULAR MILLING MACHINE.

An important departure in the way of machine tools is now being introduced into this country by Mr. H. F. L. Orcutt, of 145, Cannon street, E.C., on behalf of Messrs. Ludwig Loewe and Co., of Berlin, and which is designed to a certain extent to take the place of the lathe for various turning operations, finishing as it does at one cut any circular surface that can be produced by rotating cutters. This tool, we are informed, can be used for finishing gear wheels, grooved pulleys, flanged pulleys, pulleys with crowning face, rope pulleys, rolls, hand wheels, balance wheels, and other work of this description. In many cases, it is stated, it produces work cheaper than turning by 50 per cent. to 75 per cent., as five or six of these tools can be attended by one unskilled operator, and they will do the work of double that number of lathes. With regard to the construction of the machine, of which we give an illustration, it may be noted that the cutter spindle is driven through back gears by a powerful belt, and the outer end of the cutter arbor is supported by an adjustable tail stock. The head, which carries the part to be milled, is very solidly constructed, and is adjustable in both directions horizontally, so it can be quickly set for different cuts, and it is firmly locked in place while the cut is being made. It is provided with adjustable stops. The circular feed of the working spindle, which is 23 in. in diameter, is driven by a worm which works into a large worm gear fastened directly to the spindle. This gives a steady powerful feed. The feed is variable through a set of change gears, and the whole machine can be stopped automatically at



any desired point. The bed is cast in one piece, with the inside arranged as a tool box. All the parts are thoroughly protected from dust. A set of change gears, necessary wrenches,

and countershaft are furnished with each machine. The size of tool illustrated mills parts from 4in. to 22in. in diameter. Mr. Orcutt, it may be added, informs us that a number of these machines, which are of a special class, made by Messrs. Loewe and Co., are now successfully at work in this country.

In view of the increasing importance to be attached to the growth of electric traction upon tramways, etc., and the consequent use of intermediate gearing, either single or double, between the motor spindle and the car axle, this machine ought to prove of value to manufacturing firms, as tending to give great accuracy in the gears, whilst also lessening the cost of production.

COMPANIES' MEETINGS.

EDINBURGH ELECTRIC SUPPLY CORPORATION, LIMITED.

The annual meeting of this Corporation was held at 17, St. Andrew-square, Edinburgh, on December 23. Mr. Walter Berry presided, and there was a good attendance.

The Managers (Messrs. George Dean and Co., C.A.) submitted the third annual report, the more important portions of which were to the following effect: In the second annual report submitted to the shareholders on December 23, 1891, it was shown that there were then 206 shareholders, representing a privately subscribed capital of £31,175, and there are now 212, with a privately subscribed capital of £32,775. Since last annual meeting the Directors have taken no steps to increase the share list by advertising or otherwise, as they consider that the nominal capital of £100,000 is fairly well secured, seeing that, in the meanwhile, only nominal holdings have been applied for, which will assuredly be greatly increased if the required concession is obtained from the Town Council. The interest taken in the electric lighting of Edinburgh is daily gaining strength, and there is a strong feeling in favour of supporting a financially strong and locally influential Corporation such as this, which the citizens of Edinburgh have themselves formed. On the 20th of July last the Directors minuted the following: "In consideration of the delay of the Town Council to proceed with the electric lighting of Edinburgh, the amount of the paid-up capital of the Corporation to date, namely, £1,561. 5s., lying in the banks, be invested in city bonds or consols, and instructed the managers to take the necessary steps to have this done. The Town Councillors have now recognised that the time has come when they must move in the matter of the electric lighting of Edinburgh, and, as may be seen by the reports of their meetings, they are proceeding with the matter as expeditiously as can be expected. Judging from present appearances, certain portions of this city will be lighted by electricity before this time next year, and the Directors have every reason to hope that this Corporation will be employed to carry out the work."

The **Chairman**, in moving the adoption of the report, said that when he addressed them on the occasion of their second annual meeting he said that they were unable to report any progress toward a definite realisation of the object for which this Corporation was formed. He had to some extent to repeat the same story that day, but with the satisfactory addition that their fate must very soon be decided, for the Town Council, which had to determine if it would undertake the electric lighting of Edinburgh on its own account or delegate the authority to others, had recognised that the operations to enable it to comply with the conditions laid down by the Board of Trade must be commenced forthwith, and they would have seen from the newspaper reports that the question in all its bearings was being anxiously considered. He did not think it probable that the Town Council would undertake the work themselves. They had plenty on hand, and were already overworked. He thought it most probable that they would entrust it to this Company, first, because of the local and unrepresentative position of the shareholders; second, because of their unquestionable financial power, and, third, because their shareholders would be the most important consumers, and would have a paramount interest in seeing that the work was well and substantially done, with as little disturbance to the streets as possible. Their interests and those of the Town Council were in many respects identical. They should, of course, look for a fair return for their capital and risk, but to a certain extent their Company might be considered as co-operative. He had no authority from his co-directors for giving an opinion, but personally he thought they were entitled to aim at 7 per cent. dividend on their shares. The Directors had never advertised for shareholders or offered founders' shares or any other inducements, but nevertheless applications had come in, and they had now on their list 212 names subscribing £32,775. The great majority of their shareholders had taken small preliminary holdings with the avowed intention of increasing their interest largely if the business was carried on, and he had no doubt that all the capital which they might choose to issue would be immediately absorbed when they were prepared to offer it. The Directors had met frequently during the year, and had given much attention to new developments in electric lighting both at home and abroad, and they were quite prepared, with the assistance of their consulting and acting engineers, to enter upon negotiations at any moment. He trusted that their patience would be rewarded, and that at their next annual meeting they should not only merit the congratulations of their shareholders, but the acknowledgments of a long-suffering public for thorough work performed. He would only add that they had as many conditional orders for installations promised as justified them in anticipating solid financial success.

Mr. John M. M'Candlish, in seconding the motion, said he was very glad to hear the hopes that were entertained of something coming out of this Company. He thought the inhabitants of Edinburgh were getting very impatient on the subject of the introduction of electric lighting. They were behind many inferior towns in this matter. He also thought the public would not view with favour the Corporation taking the electric lighting into their own hands, but would rather see them making suitable terms with a company such as this. Certainly no other company had anything like the claim that they had on the Corporation.

The report was adopted, and thanks were afterwards given to the Directors for their gratuitous services.

ELMORE'S FOREIGN AND COLONIAL PATENT COPPER DEPOSITING COMPANY, LIMITED.

The third annual ordinary general meeting of this Company was held on Friday last at the Cannon-street Hotel, Mr. J. Jepson Atkinson occupying the chair. The notice calling the meeting having been read by the secretary (Mr. J. Sharmer),

The **Chairman** reminded the shareholders that the Company was a syndicate company, not for industrial operations, but for the sale of the foreign patents to companies. The assets therefore largely depended upon the success of the subsidiary companies so formed. During three years they had done well, and had paid back in dividends the whole of the priority share capital. At the end of last year the value of the assets was considerably higher than at present, but during the coming year the market value of the assets would materially improve. The Board intended to have the accounts for 1892 prepared immediately upon the expiration of the present year, and to meet the shareholders with the same not later than next February. The year 1891, now under consideration, did not see the formation of any new Elmore companies, and the year, as stated in the report, had been one of establishment and development of existing companies. After close and personal experience of the working of the companies since they last met, and notwithstanding the many seeming **failures and disappointments, he could assure them that the** coming year would be one of substantial prosperity to the manufacturing companies, from a shareholder's point of view. The Directors admitted that they had no doubt been too sanguine as regarded the length of time required to overcome the difficulties of starting and developing a new business, aggravated in one case by the smallness of the available working capital. These difficulties had, however, now been overcome, and the Elmore process to-day was, he said, perfectly successful from a commercial point of view. He was certain that the result would be a considerable improvement in their assets, and as a further consequence they would be able to dispose of other unsold patents. During the year they had had to largely assist the French Elmore Company financially, their advances to them being secured by mortgage at interest. The wisdom of that policy could not be better seen than by looking at the success which that company had achieved at its works. They had thereby secured an established value to their very large stake in the French Company in the form of shares and debentures, which would have been practically wiped out if any financial disaster had occurred to the French Company. The Directors would have been pleased to have declared a dividend of 100 per cent. to the priority shareholders, but, as stated in the report, they hoped to be able to do that in 1893. That was because he believed that the Elmore process was perfectly successful, and, consequently, with proper management, the companies would be successful, thus enabling them to realise their investments in cash. They had had only that week an offer with cash down for shares in the French Company, but it was too low and they had refused it. The Directors intended within a few weeks to publish the accounts for 1892. Now that the funds for the French Elmore Company had been arranged for, he believed that the value of the assets in the balance-sheet would be improved. He then moved the adoption of the report and accounts, which had been taken as read.

Mr. Macfarlan seconded the motion.

Mr. Inverarity moved that the accounts be not passed. He did not suggest that in any captious spirit, but in order that the rights and privileges of the priority holders should be discussed and laid down. He regretted that those privileges had been damaged by the Directors making large loans to the French Company, and which he considered as illegal and beyond the powers of the Directors. He then quoted from their articles to endeavour to substantiate that statement.

The **Solicitor** (Mr. Hays), in reply to Mr. Inverarity, quoted from the memorandum of association to show that the Company could lend to such persons on such terms as might seem expedient, and in particular to customers and persons having dealings with the Company.

Mr. F. L. Rawson then entered, in reply to various questions, into an explanation as to the reason for the advance made to the French Elmore Company. That company was "hard up," and the question was whether it was going to fail or not. If it had failed, all the companies would have done so. They therefore considered it advisable to lend the money, the security being a second charge upon the property after the £50,000 of debentures. The French Company had now managed to pull through, and arrangements had been made for the placing of the debenture stock, that company having received already £10,000 on that account. The output from the French works was between 10 and 11 tons per week, and that placed a value on the shares

which they did not have at the beginning of the year. He mentioned that people were coming over to purchase the Russian patents, and an offer made for the Belgian patents had been refused owing to its being too low. The shares in the Austrian Company would not be of any value to them until that company commenced to make a profit. Mr. W. Elmore, he said, had resigned, at the request of the directors of the English Company, so that he might devote his time solely to the Leeds works. In reply to a shareholder, he remarked that £35,000 had been received for the American patents, and that amount had been lent to the French Company, there now being only a balance to come from America of £200.

In reply to questions, the Directors promised not to lend any money or securities to other companies until the next meeting.

The motion was then put to the meeting, with the result that 28 voted for it and 22 against. The resolution was therefore carried.

Mr. F. L. Rawson, the retiring director, and the auditors, Messrs. Jackson, Pixley, Browning, Husey and Co., were re-elected, and the meeting closed with a vote of thanks to the Board.

FOWLER-WARING CABLES COMPANY, LIMITED.

Directors: Wm. Fowler, Esq., chairman; Walter Chamberlain, Esq.; R. W. Eddison, Esq.; George Fleming, Esq.; The Lord Medway; Geo. F. Smart, Esq.

Report of the Directors presented to the shareholders at the fourth ordinary general meeting held at the registered offices of the Company, Victoria mansions, 32, Victoria street, Westminster, S.W., on Thursday, the 29th December, 1892.

In submitting the third annual report, the Directors are pleased to call attention to the fact that, as they anticipated last year, there has been again an increase in the volume of business done as compared with the previous 12 months, with the result that this year a small profit has been earned. The Directors are satisfied that the business is steadily growing, and they believe that it will show continuous development with increasing profits as time goes on, more especially because a larger turnover reduces the average charge for general expenses, an item which is always disproportionately heavy in a new business; meanwhile, good orders in different departments have continued to come in since the 30th September. Some interesting details of the work done during the past year will be found in the annexed report of the general manager. As the shareholders have already been informed, the actual capital of the Company has unfortunately proved insufficient for its requirements, and the Board therefore, in May last, authorised an issue of debentures to the amount of £10,000. Of this sum £5,500 has been taken up, chiefly by the Directors themselves, after full opportunity of subscribing was given to each shareholder. This amount has sufficed for the present, but the employment of a still larger working capital will be necessary before any considerable development of the business can be suitably met. The Directors believe that such an increase would be justified by the results. Colonel J. T. North and Mr. R. S. Waring having ceased to be directors, Mr. Geo. F. Smart has been chosen to fill one of the vacancies thus occasioned. The retiring directors, Mr. William Fowler and Mr. George Fleming, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Brothers and Co., offer themselves for re-election.

General Manager's Report. In reviewing the progress of the Company for the past year it is satisfactory to note an increase in the volume of business. The electrical industry, however, has not escaped the prevailing depression, and our turnover has not yet reached a figure which would fully employ the resources of the works and staff. A brief *résumé* of the principal work completed during the year will sufficiently indicate the extent of the Company's operations, and the direction in which further developments may be confidently anticipated. In my last report I referred to our contract for mains with the London Electric Supply Corporation; this has been extended, and we are still delivering large quantities of high-tension concentric conductors for their system in London. We secured the contract for, and have now completed, the extensive underground electric light system at Exeter, and have at present a similar contract at Brighton. A number of Irish towns have been cabled on our system, and we are carrying out the contract for the electric light mains of a large town in Sweden. Negotiations are well advanced for similar contracts in this country. In general electric lighting work our manufactures have met with increasing favour, and have been in several instances specified for specially difficult conditions, to the exclusion of other systems. In telegraphy, the railway companies continue to employ our various types of telegraph cables, and we have now in hand a contract with the Secretary of State for India. This has been placed with our Company after prolonged tests and experiments by the officers of the Government in India, who have satisfied themselves as to the high value of our insulating material in resisting the deteriorating effects of the heat and moisture of the Indian climate. We are justified in expecting that this contract will be followed by the further application of our cables for electrical work in hot climates where permanent efficiency cannot be secured with rubber or guttapercha. Recent enterprise in telephony has stimulated the manufacturers to special exertions in the production of cable suitable for the transmission of telephonic currents over long distances, and notable advances in this direction have been made within the past few years. Since the organisation of the Company's factory at North Woolwich, this important work has been the subject of constant experiment and investigation, and we are now manufacturing long-distance telephone cables of the highest efficiency. It is satisfactory that the resources of our works, and the perfection of the machinery and appliances, have enabled us already to undertake and successfully to complete large contracts both in this country and abroad for the new type of cable. Notwithstanding the preliminary difficulties which always beset a new industrial undertaking, and the exceptionally keen competition which we have had to meet from the beginning of our business, the constantly growing demand in every branch of electrical engineering, and the high favour with which our manufactures have been received, foreshadow the early success of the Company.

Dr. Balance sheet, Sept. 30, 1892		£ s. d.
Capital:		
Authorised –		
40,000 shares at £5 each	£200,000 0 0	
Issued –		
20,000 shares of £5 each fully paid	100,000 0 0	
300 founders' shares issued as fully paid to vendors	1,500 0 0	
		101,500 0 0
5 per cent. debentures		5,500 0 0
Creditors		14,058 10 [illegible]
Liability on bills receivable discounted	1,448 5 11	
		£121,058 10 [illegible]
Cr.		£ s. d.
Cash at bankers and in hand		1,374 12 [illegible]
Debtors		14,1[illegible]8 12 [illegible]
Stock		25,142 [illegible]
Office furniture in City offices and in factory		5[illegible] 10 [illegible]
Shares in other companies, at cost		1,065 0 0
Machinery and plant:		
As per last account, September 30, 1891	£15,094 6 10	
Additions during the year	1,846 19 3	
		16,941 [illegible]
Works and buildings at North Woolwich:		
Outlay, as per last account, September 30, 1891	14,570 2 10	
Additions during the year	211 6 4	
		14,781 9 2
Patents and goodwill as per last account, 30th September, 1891		11,[illegible]
Preliminary expenses		3,[illegible] 15 6
Profit and loss account as per last account, 30th September, 1891	3,273 7 2	
Deduct profit for year ending 30th September, 1892, as per account	482 12 0	
		2,790 15 2
		£121,058 10 [illegible]

Profit and Loss Account for the Year ending Sept. 30, 1892	£ s. d.
Dr.	
Directors' fees (not drawn)	2,[illegible] 0 0
Rent, rates, and taxes	1,[illegible] 3 2
Office expenses and advertising	1,[illegible] 13 [illegible]
Fees on patents	107 0 0
Balance, net profit for the year ending September 30, 1892, carried to balance sheet	482 12 0
	£5,455 8 7
Cr.	£ s. d.
Gross profit on cables, after deducting salaries, maintenance of machinery, and other expenses	5,452 3 7
Transfer fees	3 5 0
	£5,455 8 7

The **Chairman** commenced by moving the adoption of the report and accounts. In doing so, he wished to make a few observations concerning the present position of the Company. They all regretted that no dividend could be declared, but he did not think that any of them were surprised at that, having regard to the fact that the Company was still in its youth, and the difficulties to meet with incidental to all new undertakings. He pointed out the important increase in the Company's business and the improvement in its position since a year ago. During the past year ending Sept. 30, 1892, the increase in the business had been over 20 per cent., and instead of having a loss of £1,500 they had turned that loss into a profit of £482, and that was a profit for the first time. There was, however, more than that. From the 30th September, 1892, to date, there had been an increase in the business of the Company as compared with the same period of the previous year of more than 100 per cent., showing at the present moment that the trade was rapidly developing. The most important point was that the working capital was still insufficient, as had been shown during the current year, when they had had to issue debentures to the extent of £10,000, almost the whole of which had been taken or dealt with by the Directors. It was important to observe, then, that probably still more capital might be required as the business developed, and it was perfectly evident if the shareholders were not disposed to co-operate with the Directors in subscribing that new capital, that additional money must be raised at heavy expense to the shareholders. But the Directors were not disposed to allow the Company to be damaged by not having sufficient working capital. He might remark that

they were all agreed in having entire confidence in the future of the Company if enough capital were provided, and without that capital they could not meet the natural development of the business. He therefore wished to impress upon the shareholders the importance of co-operating with the Directors in furnishing that capital. One reason why they had not shown a greater profit was because they had had to provide a larger plant than the current business required, because they had to be prepared to execute large orders speedily and at any time. They would, therefore, understand that the business required considerable capital, like all well-developed undertakings. He further stated that never since the Company was first founded had he seen such a list of enquiries as at the present moment. He regarded that as a satisfactory feature, without going into details, which ought to help the shareholders in forming their opinion as to the future of the Company, and in furnishing fresh capital. They were there a body of Directors—he was sorry to say almost an entire body of Directors—turned into a committee for a general meeting, but he hoped that those present would communicate the wishes of the Board to the other shareholders. He then moved the adoption of the report and accounts.

Lord Medway seconded the motion.

Mr. Seon observed that he, as he considered was the case with the other shareholders, had expected a dividend, but was surprised that such was not the case. Of course a great many of them did not place their money in a company to have no dividend for three or four years. He had £700 invested in the Company, and the only thing he saw of it was that the market price of the shares had diminished. He asked when they might expect a dividend.

The **Chairman**, in reply, did not wish to pledge his word, but he believed that during the present year they would see something in the way of dividend. He himself had a larger share in the Company than Mr. Seon, and he regretted more than that gentleman that no return had been made, because of his responsibility as a director. He had been told by a friend when the Company was formed that they would make no profit for three years, and he was surprised, but that had been their experience. They had had to work against great difficulties but he believed they were now surmounting them, and he thought the fact that a small profit had been earned was an encouraging feature.

Colonel Wyndham Murray, M.P., confirmed Mr. Seon's remarks about a dividend, and said that at the last meeting it was foreshadowed that there would this year be a dividend to divide. He also directed attention to the fact that when he bought shares at the starting of the Company it was stated that the Company at that time had been realising 24 per cent., and that there was a probability of an increased percentage.

The **Chairman**, in answer, remarked that it was quite true that a dividend had been anticipated this year, and he was as much disappointed as anyone. One great difficulty was their fixed expenses, which in a business of that nature were always very large in proportion to the business, and they had not had the amount of increase in trade anticipated a few years ago. He felt that with the good management which they had they were in a better position. With regard to the statement in the prospectus, that was quite true as far as the capital involved in the business, and he would not be surprised if the statements were fulfilled in years to come. It was far different to pay interest on a small than on a large capital. If they compared their position with that of other electrical companies, he thought they should congratulate themselves, and he believed they were on the eve of better times. He then put the motion.

This was carried without any dissentient.

Mr. George F. Smart was elected a director in the place of Colonel J. T. North and Mr. R. S. Waring, who had ceased to be directors. The retiring Directors, Mr. Wm. Fowler and Mr. G. Fleming, and the auditors, Messrs. Cooper Brothers and Co., were re-elected, and the proceedings came to a close.

GENERAL ELECTRIC POWER AND TRACTION COMPANY, LIMITED.

An informal meeting of the above was held yesterday at Winchester House under the presidency of the Chairman of the Company. As the statement and accounts were not ready, the assembly was adjourned for their preparation and presentation on January 31.

NEW COMPANIES REGISTERED.

Becket, Limited.—Registered by Loughborough and Gedge, 23, Austin-friars, E.C., with a capital of £10,000 in £1 shares. Object: to adopt an agreement, made December 15, between P. Everitt of the one part and H. H. Preece, on behalf of this Company, of the other part; to carry on business as electrical engineers and machinists, brass and iron founders, etc. Registered without articles of association.

W. Pope and Son, Limited.—Registered by H. C. Godfrey, 60, Finsbury-pavement, E.C., with a capital of £12,000 in £10 shares. Object: to adopt and carry into effect an agreement made November 30 between W. W. Pope of the one part and O. Wethered, on behalf of this Company, of the other part; to acquire the business of mechanical and electrical engineers now carried on by W. Pope and Son at Slough, and to develop and extend the same. There shall not be less than two nor more than seven directors, the first being elected by the signatories to the memorandum of association. Qualification, £100. Remuneration to be fixed by the Company in general meeting.

BUSINESS NOTES.

Cardiff.—Tenders will be advertised for shortly.

Diary.—The Brush Electrical Engineering Company sends us a neat pocket diary as a New Year present.

Underground Telephones.—Notice has been given by the St. Helen's Corporation to have in the near future all telephone wires underground.

Elmore's Patent Copper Depositing.—The profit and loss account for the year ended June 30 last shows a loss on working of £8,566. 5s. 6d.

Burnley.—The tenders for wiring of Burnley Town Hall are to be sent in by January 18th, to the borough surveyor, Burnley (specification fee, £1. 1s.).

Hampstead.—A sum of £25,000 is to be borrowed by the Hampstead Vestry for electric lighting when the sanction of the Local Government Board has been secured.

Personal.—Mr. A. Grundy is rejoining Messrs. Baily and Grundy, of Amberley Works, Paddington, as manager of the electrical and contract department, from the New Year.

Commercial Cable Company.—The general offices of the Commercial Cable Company in London have been removed from 18, Bishopsgate-street Within, to Bishopsgate House, 55 and 56, Bishopsgate-street Within, E.C.

Western and Brazilian Telegraph Company.—The receipts for the week ended December 23, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,254.

Zoological Society.—Prof. George Forbes informs us that he has just given the contract for electric lighting of the rooms of the Zoological Society, in Hanover-square, to Messrs. Drake and Gorham, as the result of competitive tenders.

Elmore's Wire Manufacturing.—The report of the Directors states that ample working capital has been provided for, that the works are completed and have been furnished with a large supply of raw copper, and that practical operations have commenced.

Buxton.—At the meeting of the Buxton Local Board on Friday, a report was presented from the committee appointed to enquire respecting cost of electric light for Buxton. After a long discussion it was decided to obtain estimates for a central installation.

City and South London Railway Company.—The receipts for the week ending December 25 were £927, against £871 for the corresponding period of last year, or an increase of £56. The total receipts for 1892 show an increase of £2,127 over those for the corresponding period of 1891.

Halifax.—The Halifax Gas Committee on Friday adopted a resolution recommending the Town Council to take steps for supplying electricity for lighting purposes, under the powers of the Halifax Corporation Electric Lighting Order, 1892, and to advertise for an electrical engineer at the salary of £200 a year.

Pontypool.—At a special meeting of the Pontypool Local Board last week, the clerk reported that he had received the copy of the license of the Pontypool Electric Light and Power Company, Limited, from the Board of Trade, asking for the Board's observations thereon before they granted it. It was decided to consider it in committee.

New Popp Company.—M. Victor Popp has organised a new company under the title of Société Générale d'Eclairage et de Force Motrice, 22, Rue d'Aumale, Paris, with a capital of 400,000f. The company takes the concession until 1907 for lighting the Entrepôts de Bercy, and will exploit compressed air, hydraulic, and electric distribution of power.

Llandudno.—The question of an electric tramway came before the Llandudno Commissioners at their monthly meeting. It was resolved to defer dealing with the matter until next meeting, Mr. Dunphy remarking that he hoped Mr. Kingsland (the promoter of the scheme) would not think there was much chance of getting a tramway along the beach.

Windsor.—The Windsor Electric Lighting Company have completed laying the mains in Peascod-street, High-street, and Thames-street, and the pavements have been replaced. A number of connections have been made with business establishments in each of the three streets, especially in the High-street, and it is expected that before long the light will be in use.

Santiago.—With reference to tenders for Santiago, all proposals will be opened on March 1, 1893, in Santiago, and a deposit certificate to the order of the Municipality of 20,000dol. (Chilian currency) must accompany each tender. The particulars of the tender and the plan of the city of Santiago may be seen at the office of the Chilian Legation, 5, New Burlington-street, W.

Pilsen Electric Company.—We are informed that Messrs. Gwynne and Co., the well-known engineers, of Essex-street Works, Strand, W.C., have acquired the entire business, patents, and rights of the Pilsen Electric Company, which will in future be carried on as Messrs. Gwynne and Co.'s electrical department at their new works, Brooke-street Works, London, E.C., in large and well-equipped premises.

Uxbridge.—At the last meeting of the Uxbridge Local Board of Health a letter was read from the secretaries to the Uxbridge and Hillingdon Gas Consumers' Company, complaining of the electric tell-tale cable being laid in undue proximity to their mains. We can quite understand how humanity desires to keep at a distance from a mad dog, but we cannot quite understand the harm that an electric tell-tale cable would do to a gas main.

Edinburgh.—From our last issue it will be seen that the Edinburgh Town Council had appointed a deputation to enquire into the electric lighting at various places. The deputation have made visits to London, Newcastle, Bradford, Cambridge, and Oxford, and have secured a large amount of information about the stations at these places. The cost of the deputation was £145.

Electrical Power Storage.—An everlasting reminder, in the shape of a blotting-pad, has reached us from the Electric Power Storage Company. This useful desk book contains diary, memorandum, slip, and pad. The company send also a price-list sheet of their central station cells, giving the curve of voltage of their 42 K cell, discharging at 290 amperes for one hour, and at 50 amperes for 10 hours. Every practising electrical engineer should secure the E.P.S. pad.

Scarborough and Brighton.—Apparently semi-official notes in the Scarborough papers comment bitterly on the request of the Brighton authorities for more money for electric light, and congratulate Scarborough on having a nice private company to take all the risk and do all the work. Why was not Bradford and St. Pancras quoted? The time for seeing whether ratepayers have done wisely in giving electric lighting powers to companies will be later, when the wise virgins in the list of towns are giving good light at low price. In large and fashionable towns the risk, under proper management, is little enough and the promise of profit large.

Telephonic Charges.—At the last meeting of the Cleckheaton Chamber of Commerce, a letter was read from the Newport Chamber stating that the Post Office had acquired the whole of the trunk telephone lines of the country, and had given notice to renters that from the 1st of January next the annual rentals would be abolished, and a charge would be substituted for each conversation, according to distance, with monthly settlements. Great surprise was expressed at this letter, as nothing had been heard of the subject in the town. The secretary was directed to make enquiries, as the Chamber were of opinion that the proposed change was highly objectionable.

Edinburgh Tramways.—Among the parliamentary measures issued in view of next session is the Bill promoted by the Corporation of Edinburgh for authority to use cable or electrical power "on the tramways acquired and to be acquired" by them, and to make arrangements "for the purchase by the Magistrates and Council of other tramways," etc. The Bill is divided into 22 sections, which cover some nine pages of print, and the promoters suggest as its short title "The Edinburgh Corporation Tramways Act, 1893." Section 6 provides that, if and whenever the Corporation shall have authority to use cable or electrical power, the Corporation may lay down and maintain works necessary for using such power.

Theatre Lighting.—Messrs. Vaughan and Brown have been busy in the lighting of theatres, having recently installed the Trafalgar-square Theatre with 900 lights distributed throughout the building, including some very handsome fittings. They have also fitted "Sexton's" large horse repository in Holborn, which has been in turn theatre, circus, and music hall. They have also fitted over 1,000 lights at the New Palace Theatre, which opened with such *éclat* a short time since. A brilliant crystal glass basket makes a striking effect in the centre of the auditorium ceiling, and a handsome four-tier electrolier lights the well of the grand marble staircase, and numerous brackets in the Renaissance style, with imitation electric candles, are fitted in other parts of the building. The whole of this work was executed in a very short time under the personal supervision of Mr. G. C. Vaughan, jun., M.I.E.E.

Utilising a Corn Mill.—Messrs. Verity and Sons have installed an interesting electrical plant at Hunton for lighting Cheveney, the residence of Mr. T. D. Eden and Mrs. Alexander. The water-wheel, which a few years ago worked the grindstones of Hunton mill, is now driving a dynamo, the current being sent through an underground cable to Cheveney and the Yalding Vicarage. The institute, boys' brigade drillroom, and Riverside, the residence of Mr. Hennah, are also lighted from the same source. A public ceremony was held at the Cheveney Institute to inaugurate the new light, which was switched on in the presence of a large number of inhabitants. Mr. Coles, engineer to Messrs. Verity, gave an account of the installation, which comprises a storage battery of the capacity for 100 16-c.p. lamps for eight hours. The Rev. D. Lamplugh also addressed the meeting, referring to the many acts of generosity done by Mrs. Alexander and Mr. Eden. The lighting was a great success, and the ceremony was followed by an entertainment.

Bournemouth Pier and Gardens.—The Bournemouth Lighting Committee reported, at the Town Council meeting on Tuesday, that they had considered the surveyor's report upon his examination of the various schemes and tenders submitted in competition for the lighting of the pier and gardens by electric light, in which he recommended that the scheme and tender of Messrs. Goddard, Massey, and Warner, of Nottingham, be accepted. The committee adopted his recommendation, subject to reference to the Council. The committee further recommended that Messrs. Goddard, Massey, and Co. be asked to submit an additional tender for providing 3,000 1-c.p. lamps for illuminating purposes, and for laying on the light to the fountains to be constructed in the gardens. The report was adopted, the chairman of the Lighting Committee (Councillor Moore) remarking that the committee considered the surveyor's report a very clever and exhaustive one, and that if carried out they would get a very satisfactory lighting of the gardens and pier.

Ipswich.—At the meeting of the Ipswich Lighting Committee, upon the minute relating to the Ipswich Electricity Supply Company, the town clerk said he had interviewed the Board of Trade on the subject, and they said the company had no legal standing. There were certain conditions to be complied with before the order was granted, and the company had not complied with the conditions, and the Board of Trade declined to recognise them. Mr. Brand said the town then would be open to any of the companies to make application. This company now ceased to exist. The town clerk said at Taunton the same state of things existed, and the Local Authority there were taking steps to take over the powers and plant of the company. The vice-chairman said it was a great pity the same thing could not be done at Ipswich. Mr. G. F. Josselyn moved that the committee do not desire that any further indulgence be granted to this company, which was agreed to.

Liverpool Polytechnic.—The annual general meeting of the Liverpool Polytechnic Society was held at the Royal Institution, Liverpool, on Monday, the 19th inst., Mr. Thos. L. Miller, A.M.I.C.E., president, in the chair, when the ballot was taken for officers and council for 1893—Dr. Geo. Tate, F.I.C., F.C.S., being unanimously elected president for the ensuing session. The president, Mr. Thos. L. Miller, then delivered his retiring address, the subject selected being "The Transmission of Power to a Distance." In opening the address, the transmission of power by means of shafting was referred to and figures given to show the limits within which it could be economically applied. Wire-rope transmission was then discussed, and examples given of installations on this system at various places on the Continent. Hydraulic transmission was then fully dealt with, its history detailed, and the limits of its application pointed out. Transmission by compressed air was then referred to, the recent advances in the construction of stage compressors described—as an example the installation at Paris on the Popp system was given. Transmission by gas, steam, and hot water were then touched on and the steam distribution plant at New York described. Electrical transmission then followed—the use of continuous, alternating, and rotary current systems being fully dealt with—the address concluding with descriptions of various installations where the different systems of electrical transmission had been adopted.

Barnet.—At a special meeting of the Barnet Local Board, the expenditure which would be incurred in the introduction of the electric light was considered. Prof. Robinson had reported as follows: "With reference to the counsel you propose to take about the estimate, and the amount the Board have to decide shall be expended, I have made a rough calculation and find that with a station in a fairly central position, an outlay of about £10,200 would be required for an installation to serve about 2,000 16-c.p. lamps, installed (or a corresponding amount of current for other purposes) with mains in the following roads: High-street, Market-place, Wood-street, and Union-street. From these arterial mains service mains can be laid to supply current in other roads as the demand arises, for which provision should be made as regards capital. To supply a further number of lights will not involve a corresponding outlay: for instance, a further 1,000 lights could be supplied with an additional expenditure of about £1,300. I have thought it desirable to give you this information so that you may determine, with or without the concurrence of the Board, what amount shall be put in the estimate for the Board of Trade of the capital of the expenditure. I suggest the estimate being framed as follows:

Central station plant	£6,150
Land and buildings	850
Electrical mains	4,500
	£11,500

This outlay would, of course, be incurred by degrees. Please to let me know that these figures are adopted." After considerable discussion, the following resolution was carried unanimously: "That the figures as submitted by Prof. Robinson, together with the plans produced and all necessary particulars, be signed by the clerk and forwarded in due course to the Board of Trade."

Poole and White, Limited.—The meetings of the creditors and shareholders of this Company were held on the 22nd in London before Mr. Warley, Assistant Official Receiver. The Company was formed to acquire the business of electrical engineers previously carried on by Messrs. Poole and White in London, branch offices being subsequently opened at other parts, including one at Manchester. The chairman remarked that, according to the statement made to the Official Receiver, there was a surplus (after payment of debenture-holders and preferred claims) sufficient to provide 20s. in the pound for the creditors. He understood that some scheme was under consideration by which that result might be brought about. Mr. John Tryan (solicitor and director) explained to the meeting the past and present condition of the Company, and that the inability to pay the debts arose from the fact that the purchases had been too large. The death of the Duke of Clarence, and the consequent stagnation of business in London, greatly reduced the sales, to which fact he partly attributed the difficulties of the Company. He expressed his belief, however, that the business was inherently sound, and, with additional capital and judicious administration, might be made a success. Mr. Street (Ward, Perks, and M'Kay) appeared on behalf of the International Okonite Company, and said it was the opinion of influential creditors that an independent liquidator and a committee of inspection should be appointed to investigate the books, with a view to arriving at a scheme for either a reconstruction of the old company or the

the company, and eventually, upon an appeal which the company made to the decision of an arbitrator, the Court of Queen's Bench informed them that they could not go behind the company's accounts except for a period of one year. The result of these proceedings, however, was to reduce the price of gas to 3s., at which figure it had remained since 1887. At the time of the passing of the Electric Lighting Act of 1882 the attention of the Council was directed to the privileges corporations had of becoming the distributors of this new illuminant. They had suffered from the experience of three companies in their town — the tramway company, the water works company, and the gas light company — who broke up their roads for the purpose of making the necessary repairs, and left them in a very unsatisfactory condition, and he for one was strongly opposed to another company being allowed to come into the town. From the first inception of the scheme to the sealing of the contract with the Brush Electric Light Company, not a single hand had been held up in the Council against these proposals. They were all aware that the electric light was an acknowledged success. Three years ago the Bradford Corporation decided to have an installation, for which they borrowed a sum of £45,000. The capacity of that installation was only equal to the one they proposed to adopt, at half the cost, and during the last 12 months the sale of current amounted to £6,600. The working expenses were £3,028, and they carried to net revenue account £3,715. 2s. 9d. Of that sum £1,074 was transferred to the sinking fund, and £1,255 for the repayment of principal and interest, leaving a balance of net profits of £1,385. With regard to the street lighting of Hanley, he would point out that they had in the limited area 53 gas lamps at present in use. Last year the cost to the Council was £300. 19s. 9d. Under their electric lighting scheme they proposed to replace those lamps with 20 arc lights, or 30 smaller lights, which could be supplied for £304. With regard to their public buildings, they had in use at the Free Library 107 lights, which last year cost £126 for gas. Less than two years ago the reading-room was painted, but it was now in a very dirty state, and really wanted redoing. He believed that in this respect considerable economy would be saved by the introduction of the electric light. The Corporation felt that they should not allow a private company to come into the town, but that the profits should be applied for the benefit of the ratepayers or the consumers. The standard fixed by the order was not to exceed 8d. per unit, but they hoped to supply the light at 6d. per unit. Mr. W. Tunnicliff, Alderman Shirley (chairman of the General Purposes Committee), and Mr. Edmund Jones also supported the application. Mr. H. Palmer said a great deal of what had been said was in the air. Hanley contained a working-class population in every sense of the word, and the burden upon their shoulders was already too heavy. Newcastle-on-Tyne had made advantageous terms with two companies for the supply of the electric light, and had thus relieved the town from all expense and risk. Why should not Hanley make similar terms with some company? The Council knew practically nothing of the scheme, and there were at least 14 members on the Council who were opposed to it. He contended that, on the showing of the Brush Electrical Company, the cost of the 20 arc lamps would be £512 No canvass of the town had been made with the view of ascertaining to what extent electricity would be consumed. A great deal had also been said as to the improvement and beneficial results which would be derived from the introduction of the electric light to their manufactories, but—General Crozier: I have had some experience of the factories so lighted, and nothing you can say will induce me to believe that gas in a workshop is better than electric light.—There were very few large residential houses in the town, and he failed to see where the light would be consumed except in the few streets confined within the compulsory area. Councillor Granville said the rates were at present 5s. 9d. in the pound, and considering the heavy indebtedness of the borough he strongly opposed any further expenditure. General Crozier: You assume that there will be a loss by the introduction of the electric light. Mr. Granville: I do. I fear the risk of a heavy charge being made upon the rates. Councillors Ball and Pickin also opposed. Mr. Geipel said a statement had been made to the effect that 1d. per unit of electric light was equivalent to 1s. per 1,000 cubic feet of gas. That was a computation which his company made some five years ago, when the incandescent lamp was not so efficient as it was at present. The manufacture of the lamps was a monopoly enjoyed by one firm only, but at the end of 1893 the patent would expire, and competition would make them cheaper. Some companies were able to supply the light at 4½d. per unit, and yet make a profit of 5 per cent. General Crozier said experience showed that at the end of two or three years the electric light was practically self-supporting, but what he wanted to know was whether, in the meantime, they would have to levy an additional rate, and, if so, how much? He had no figures as to the number of persons who would be likely to consume the light. The Mayor said he had been frequently urged by shopkeepers not to allow the matter to be delayed any longer, and Alderman Cooke said it was perfectly certain that if one shopkeeper had an installation the remainder would follow. Messrs. John Whitehead, John Rawson, Samuel Hodson, Charles Edwards and Councillor Schofield also opposed the application on behalf of working-men. They contended that the borough was in a state of bankruptcy, and that their fellow working-men were severe sufferers through scarcity of work and the heavy rates, which they were not in a position to pay. It was also urged that a canvass of the town should be taken with a view of ascertaining the views of the inhabitants in the matter. The enquiry, which lasted over four hours, was then concluded with a vote of thanks to the inspector.

PROVISIONAL PATENTS, 1892.

DECEMBER 14.

23023. **An improved system of telephonic news transmitter.** Theodor Puskas, 45, Southampton-buildings, Chancery-lane, London.

23039. **Improvements in electrical connections or means for supplying current to electric motors.** Wilhelm von Winkler and Julius Fekl, 47, Lincoln's-inn-fields, London.

DECEMBER 15.

23051. **Improvements in galvanic dry cells.** Edward Albert Mitchell and George Thomas Tugwell, 3, Penmartin-road, Brockley, Kent.

23054 **Improvements in medical and other electric induction coils.** Joseph Walker Davis, The Cedars, Tettenhall-road, Wolverhampton.

23057. **Improvements in fittings for use in electric light installations.** Frederick King and William Phillips Mendham, Western Electrical Works, St. Peter, Bristol.

23061. **Improvements in or connected with portable electric lamp fittings.** Wilson Henry Sturge, 12, Cherry-street, Birmingham.

23068. **Improvements in mechanical and electrical interlocking of railway signals, signal or other levers, and block telegraph instruments, commonly called lock and block.** Alexander Ross, Thomas Wharmby, and Robert Stuart Hampson, 17, St. Ann's-square, Manchester.

23086. **Improved arrangement for communicating by telephone between several stations.** Robert Daniel Smillie, 154, St. Vincent-street, Glasgow. (Complete specification.)

23101. **New primary batteries.** Carl Anton Johannes Hugo Schroeder and Heinrich Eugen Richard Schroeder, Wheatstone House, Heslop road, Balham, London.

23113. **Apparatus for determining differences between the phases of two electric alternating currents of like number of alternations.** Michael von Dolivo-Dobrowolsky, and the Co. Allgemeine Elektricitäts Gesellschaft, 47, Lincoln's-inn-fields, London. (Complete specification.)

DECEMBER 16.

23158. **Improvements in electrical meters.** Paris Eugene Singer, 6, Victoria-road, Kensington, London.

23159. **Electro-mechanical depth indicator.** Arthur R. G. Beal, Longford House, Holyhead, North Wales.

23185. **Improvements in and connected with alarm clocks and electric sound signalling appliances.** Walter Fielder and Henry Newmarch, 166, Fleet-street, London.

23218. **An electric mechanism or device for operating valves.** Jacob Wagner, 1, Quality court, Chancery-lane, London.

23231. **Method of effecting in electric incandescent lamps an airtight union between entering wires made of non-precious metal, and the glass globe.** Paul Scharf, 28, Southampton-buildings, Chancery-lane, London.

23232. **Improvements in and relating to secondary or storage batteries.** James Yate Johnson, 47, Lincoln's-inn-fields, London. (August Marie Michel, France.) (Complete specification.)

DECEMBER 17.

23269. **Varying price electric supply meter.** John Perry, Michael Birt Field, and Louis John Steele, 31, Brunswick-square, London.

23290. **Improvements in alternate-current motors for single and polyphase electric currents.** Engelbert Arnold, 28, Southampton-buildings, Chancery-lane, London.

23295. **An improved centrifugal device for opening or closing an electric circuit.** Sir David Lionel Salomons, Bart., Broomhill, Tunbridge Wells.

23314. **The automatic electric fire alarum.** Elizabeth Fanny Cox, 44, Thornton road, Thornton Heath, Surrey.

COMPANIES' STOCK AND SHARE LIST.

Name	Paid.	Price Wednesday
Brush Co.	—	3½
— Pref.	—	2¼
City of London	—	10½
Electric Construction	10	2½
Gatti's	—	5¼
House-to-House	5	3¾
India Rubber, Gutta Percha & Telegraph Co.	10	22
Liverpool Electric Supply	5	5¼
	3	2½
London Electric Supply	5	4
Metropolitan Electric Supply	—	6¾
National Telephone	5	4¼
St. James'	—	8½
Swan United	3¾	3¼
Westminster Electric	—	6